EPIDEMIOLOGY OF DENTAL CARIES AND THE LEVEL OF ORAL HEALTH LITERACY AMONG ADOLESCENTS IN RURAL AND URBAN AREAS OF TAMIL NADU, INDIA

A thesis submitted in partial fulfilment of the requirements for the Degree

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by Arthi Veerasamy

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The material presented in the thesis is the original work of the candidate except as acknowledged in the text, and has not been previously submitted, either in the part or in the whole for a degree at this or any other university.

Arthi Veerasamy

நோய்நாடி நோய்முதல் நாடி அதுதணிக்கும்
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திருவள்ளுவர் (முதலாம் நூற்றாண்டு, கி.மு*).*

"Know the illness, trace its cause, seek the proper remedy and apply it with skill"- Couplet 948

Thiruvalluvar (1st Century BC)

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Abstract

Introduction: The literature review indicated that oral health is a serious health issue among Indian school adolescents. In India, less than 5% of adolescents have access to organised public dental health services in order to identify and treat dental caries at an early stage. Oral health literacy is important for adolescents to prevent and manage dental caries in their permanent teeth. Currently, there is no formal oral health education available in both the primary and secondary level school curriculum in Tamil Nadu.

Objective: This thesis was conducted to collect baseline data to measure the epidemiology of dental caries and the level of oral health literacy among adolescents in rural and urban schools of Tamil Nadu, India.

Methods: Oral health literacy and the epidemiology of dental caries were measured in 974 adolescent school students (12-15 year-olds) from both rural and urban areas of Tamil Nadu, India. There were three research questions answered in this thesis using a cross-sectional descriptive correlational quantitative study design. The first research question was addressed by measuring the Decayed, Missing and Filled teeth index (DMFT) using the WHO oral health survey method. The second research question was addressed by measuring the oral health literacy of 974 adolescent participants using a self-administered questionnaire developed for this study. The third research question was addressed by examining the association between the severity of dental caries (question 1) and oral health literacy (question 2).

Results: The oral health survey indicated that prevalence of dental caries among adolescents in rural and urban parts of Tamil Nadu was 61.4% with an average DMFT score of 2.03. Multiple regression analyses indicated factors such as gender, age, mother’s education, type of schools and community/caste as significant predictors of dental caries. This is the first study to assess the impact of community on oral health literacy and status of adolescents. Almost 92% of participants reported that they had never been to a dentist. In total, 1980 teeth were affected and 98.6% (1953) affected teeth were decayed and not filled.

The Cronbach's alpha score (0.651) demonstrated the developed questionnaire had good internal consistency. In total, 35% of participants had poor oral health literacy (OHL) skills and only 8.3% of participants had good OHL skills to prevent dental caries. Parent's education, gender and community/caste were identified as significant predictors of OHL in the regression analysis. A strong negative association between oral health literacy scores and dental caries prevalence and severity was identified in the study.

Conclusion: The current study is the first to find an association between oral health literacy and dental caries in an adolescent population both in international and Indian literature. The prevalence of dental caries was decreased and severity of dental caries was increased when compared to previous research in Tamil Nadu. This result implies an imbalance in availability of oral health services in Tamil Nadu, India. The study results also imply that the majority of the study population had poor or moderate oral health literacy to prevent and manage dental caries.

Females, Scheduled Caste and Tribes attending public schools in rural areas were identified as the more vulnerable populations to get affected by dental caries due to their poor oral health literacy. Oral health policies should be targeted to these adolescent populations in the Tamil Nadu region. Improving oral health literacy education in the school and pre-school curriculum could help to manage oral health in adolescents.

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Chapter 1: Introduction and Background

1.1 Introduction

The current thesis topic uses a quantitative cross-sectional study to explore oral health status and oral health literacy in regards to dental caries in 974 participating adolescents of Tamil Nadu, a southern state of India. Chapter one provides the background on dental caries and health literacy with an overview of the Indian health and oral healthcare system. Chapter two reviews the relevant literature. A literature search was conducted separately for dental caries in India, and for oral health literacy, and these two are discussed in two sections. Flow charts and tables are provided to show the review process. Chapter three presents the methodology used for the current research and procedures adhered to for the data collection, data management, ethics procedures, and construction of the questionnaire, pilot study and analyses of the data. Chapter four presents the findings for the research questions. This chapter is divided into three sections and results are discussed with the help of charts and tables. Chapter five provides an in-depth discussion of the findings and their relationship to relevant literature. The implications of the results are discussed for all significant findings with relative applicability to the Indian Ministry of Health, Ministry of Education, adolescents, teachers and the parents. Chapter six presents the recommendations and conclusions of the thesis research along with a summary of the study limitations as well as suggestions for future research.

1.1.1 Statement of the Problem

There has been remarkable progress in the reduction of dental caries in developed countries over the past 30 years (Chen & Hunter, 1996). The 1997 World Health Organisation (WHO) international collaboration study is one of a number of prevalence studies that have been conducted on the incidence of dental caries and treatment needs in different parts of the world. In developing countries, such as India, preventing dental caries is in the early stage of implementation and the incidence of dental caries reported is in the range of between 31% and 89% (Grewal, Verma, & Kumar, 2009).

Dental caries is the most common chronic contagious disease affecting humans, especially young children. It is estimated that 50 million school hours are lost annually in the United States of America because of dental caries in school children (Silk, 2010). Research indicates that a strong link exists between health and learning. The students who have poor health show underachievement, while healthy students generally have opportunities to perform better in school. Oral health has a strong connection with general health and also the pain and discomfort caused by dental caries will affect a child’s performance at school (Selwitz, Ismail, & Pitts, 2004).

Over the past few decades, the position of adolescents in society has changed with an increasing recognition of adolescents’ rights and needs. Health is an important need for young children so that they are able to achieve everything they want and to live in a meaningful life. Oral healthcare is very important during the early adolescent stage owing to the higher risk of dental caries and periodontal diseases (Carranza & Newman, 1996). Although dental caries in adolescent is considered a serious concern among researchers and epidemiologists, periodontitis and gingivitis are other major concerns during puberty (Carranza & Newman, 1996).

Hormonal changes related to puberty can put teens at greater risk of getting periodontal disease. During puberty, an increased level of sex hormones, such as progesterone and possibly oestrogen, cause increased blood circulation to the gums (Carranza & Newman, 1996). This may cause an increase in the sensitivity of the gums and lead to a greater reaction to any irritation, including food particles and plaque and therefore greater care is required to prevent gingival and periodontal diseases. Evidence shows that periodontal disease may increase during adolescence owing to lack of motivation to practise oral hygiene (Carranza & Newman, 1996). Children who maintained good oral health habits through childhood years are more likely to continue brushing and flossing during their adolescence than children who were not taught proper oral care. Oral health literacy has a decisive influence on adopting and sticking to healthy oral health behaviours (Horowitz & Kleinman, 2008). A few studies in some parts of India indicate that oral health awareness among adolescents is very low (Caufield, 2005; Harikiran, Pallavi, Hariprakash, Ashutosh, & Nagesh, 2008). Oral health literacy intervention is therefore needed for adolescents to improve their oral health outcomes.

The literature review indicates that oral health is a serious health issue among Indian school adolescents. In India, less than 5% of adolescents have access to organised public dental health services which would permit the identification and treatment of dental caries at an early stage (Singh & Purohit, 2012). The prevalence of dental caries and other dental treatment requirements in Tamil Nadu school students have not been adequately identified for either the urban or rural adolescent populations in the time since the National Oral Health Survey conducted 13 years ago. The 2002-2003 National Oral Health Survey conducted by Dental Council of India indicated that prevalence of 49.8% and mean DMFT (Decayed, Missing and Filled Teeth) of 2.5 among 12 year olds and 3.4 in 15 year olds (Bali, Mathur, Talwar, & HB, 2004). The oral health literacy of current Indian school children has not been identified and there is also no formal oral health education provided. The current thesis has been designed to fill the gaps in knowledge of these important public health issues for the second most populated country in the world.

1.1.2 Significance of the Study

1.1.2.1 Oral health status of adolescent

The current study intended to discover the prevalence and severity of dental caries among 12-15 year old school students. To ascertain the incidence of oral diseases, various studies have been carried out among school children between the ages of 6 and 12 in Tamil Nadu. The last nationwide oral health survey conducted which included any 15 year old adolescents from Tamil Nadu was 13 years ago in 2002. In 2007, the WHO has conducted a multi-centric study comparing oral healthcare needs in different states of India but the State of Tamil Nadu was not included in that study (Shah, Pandey, Duggal, Mathur, & Rajan, 2007). Changes in country's economic status as well as changes in diet have compromised the oral health status of the Tamil Nadu population. Adequate data are not available to understand the oral health status of the adolescent population living in rural and urban areas of Tamil Nadu and such data are required to develop effective intervention and prevention strategies. The current study is therefore designed to fill this gap in the knowledge base and to discover the prevalence and severity of dental caries among adolescents. This can then inform the implementation of future intervention programmes.

1.1.2.2 Oral health literacy in adolescents

Indian oral health services are very limited, and comprise primarily private clinics and only a few public hospitals. There is no organised school dental service, which, if it were to exist, could help prevent dental caries and treat dental caries in the early stages. Oral health awareness among the public including school children is very low (Harikiran et al., 2008). The best way to prevent dental caries is to improve the oral health literacy of adolescents. For that, as a first step, the existing level of oral health literacy among adolescents needs to be measured. Even though many studies have investigated adolescents' knowledge and attitudes regarding oral health, oral health literacy is still a new concept in Indian literature, and there have been no studies conducted to measure the level of oral health literacy in adolescents. Measuring oral health literacy among adolescent school students would help the state Government to implement oral health promotion programmes in schools. The current study measured the oral health literacy level in different groups of the population such as by the location of the school (urban, rural or village) and also by school organisational type (public or privately funded) as this would help to discover the level of intervention needed to improve the oral health literacy of the adolescent population in different socioeconomic strata of Tamil Nadu.

1.1.3 Research Questions

The current study investigates:

1. What is the prevalence of dental caries among 12-15 year old school students in Tamil Nadu?

With respect to:

- Gender
- Urban and rural population
- Private and public schools
- Community/Caste
- Other sociodemographic variables

2. What is the oral health literacy of adolescents living in rural and urban areas of Tamil Nadu?

With respect to:

- Gender

- Urban and rural population
- Private and public schools
- Other sociodemographic variables
- Community/Caste

3. What is the association between oral health status and oral health literacy in adolescence?

With respect to:

- Gender
- Urban and rural population
- Private and public schools
- Community/Caste
- Other sociodemographic variables

1.2. Background

Dental caries is the most common chronic disease affecting most of the population all over the world, with a higher incidence in developing countries (Bagramian, Garcia-Godoy, & Volpe, 2009). It is characterised by the dissolution of the dental enamel and dentine and in its later stage infection of the pulp. This eventually destroys the affected tooth surface or the tooth itself (Caufield, 2005). The consequences of dental caries include loss of teeth, difficulty in eating and speaking, malnutrition, lack of self-esteem and bacteremia (Sturdevent, Roberson, Heymann, & Studevent, 1994).

Dental caries is, on the other hand, considered to be one of the most preventable infectious diseases (Caufield, 2005). Dental caries can be prevented by having a healthy attitude and behavior towards oral health (Horowitz & Kleinman, 2008). Improved health literacy promotes individuals following healthy behaviours using the basic knowledge about oral hygiene procedures and this behaviour will be sustained by knowing the effect of dental diseases (Naidu, 2008).

Health literacy is an excellent solution that can militate against the confusion about diseases and available treatment options (Kickbusch, Maag, & Kris, 2008). Basic health knowledge is important to accomplish a healthy lifestyle and a modern healthcare system demands that health consumers learn and understand health information (Don Nutbeam, 2008). An individual’s health literacy correlates to their education and its adequacy is affected by different factors such as age, culture, ethnicity and the existing health facilities (Don Nutbeam, 2008).

Even though research argues that dental caries is almost 100% preventable (Nelson, 2012), the majority of the population is not aware that there are certain measures available to prevent dental caries (Nelson, 2012). Oral health literacy allows everyone to understand that such preventive measures and dental services exist. Research also indicates that oral health literacy helps the public to understand how to access available dental services, use them appropriately, be persistent in using them, and ask questions of their health providers. Thus, oral health literacy should be the best option to eradicate dental caries and other preventable oral diseases.

In this chapter, the background to health literacy, dental caries, the structure of the Indian healthcare system and the history of Caste system are discussed.

1.2.1 Health Literacy

Measuring oral health literacy in adolescent was one of the main research questions in the current study. Health literacy is “the degree to which individuals have the capacity to obtain, process and understand basic health information and services needed to make appropriate health decisions" (Eagle, Reid, Hawkins, & Styles, 2005). General literacy is often correlated with health literacy. But health literacy is not just reading prescriptions, speaking or listening to health providers; it also includes acquiring background information about health and then acting appropriately on that information. Health literacy gives a patient the ability to provide significant information to the physician for diagnosis and a treatment plan.

Patients have been viewed as the "primary healthcare workers" (Fang, Machtinger, Wang, & Schillinger, 2006) who deal with most of their own illnesses themselves most of the time. Because of the cost of appointments, and increased medical queues in specialty care, patients are forced into a situation of self-care. A shift from acute to chronic ill-health automatically involves patients in their own care.

Patients with chronic diseases necessarily resort to self-management with day-to-day management of long term and continuing illnesses such as asthma, diabetes, and arthritis (Coultzer, Parsons, & Askham, 2008). Educating patients about self-management can improve their health knowledge and help them to adopt to the treatment recommendations (Coultzer et al., 2008). Self-management initiatives appear to work better when integrated into the normal healthcare system. Involving patients in clinical decision making through informed choices and improving their knowledge of disease conditions may enable them to practise better self-management and prevention of diseases.

The concept of health literacy applies to all aspects of health, including oral health. The growth in information technology and the rapid advances in dental scientific knowledge demand an ever-increasing understanding of oral diseases by the public for good decision making (M. Jones, Lee, & Rozier, 2007). Individuals belonging to socioeconomic disadvantaged groups with low incomes and those with less education have fewer skills to obtain information about preventive services or available treatment options. These people should be identified by healthcare providers and their health literacy level should be measured to help them understand information about healthcare (Richman, Lee, Rozier, & Gong, 2007). The awareness and importance of oral health literacy have grown and efforts have been directed at adopting the concept of health literacy to dental practice and research (M. Jones et al., 2007)

Even though the word “health literacy” has been recognised for more than 30 years (Baker, 2006), health literacy work has mainly concentrated in few developed countries such as the United States, Canada, Australia, Korea, Japan, the United Kingdom, the Netherlands, and Switzerland (Sorensen et al., 2012).

1.2.1.1 Definitions of health literacy

There are various definitions available in the literature for health literacy. The first is the WHO definition of 1998 (see Table 1). Later definitions changed as there was growth in the understandings of health literacy. Almost all current definitions include the notion of a “set of skills to achieve good health”. Some definitions were limited and viewed health literacy merely as an ability to read and understand healthcare materials. Recent definitions include the concept of participating in healthcare decision making as an important domain for health literacy. The majority of definitions (see Table 1 and 2) now include not only having a set of skills to stay healthy, but also to improve quality of life.

Table 1: Health Literacy Definitions from Systemic Review Study (Sorensen et al., 2012, p. 4)

	Reference (Year; Page)	Definition
1	WHO (1998)	"The cognitive and social skills which determine the motivation and ability of individuals to gain access to understand and use information in ways which promote and maintain good health"
2	American Medical Association's (1999)	"The constellation of skills, including the ability to perform basic reading and numeral tasks required to function in the healthcare environment"
3	Nutbeam (2000)	"The personal, cognitive and social skills which determine the ability of individuals to gain access to, understand, and use information to promote and maintain good health"
4	Institute of Medicine (2004)	"The individuals' capacity to obtain, process and understand basic health information and services needed to make appropriate health decisions"
5	Kickbusch, Wait & Maag (2005)	"The ability to make sound health decision (s) in the context of everyday life--at home, in the community, at the workplace, the healthcare system, the market place and the political arena. It is a critical empowerment strategy to increase people's control over their health, their ability to seek out information and their ability to take responsibility"
6	Zarcadoolas, Pleasant & Greer (2003, 2005, 2006)	"The wide range of skills, and competencies that people develop to seek out, comprehend, evaluate and use health information and concepts to make informed choices, reduce health risks ad increase quality of life"
7	Paasche-Orlow & Wolf (2006)	"An individual's possession of requisite skills for making health-related decisions, which means that health literacy must always be examined in the context of the specific tasks that need to be accomplished. The importance of a contextual appreciation of health literacy must be underscored"
8	EU (2007)	"The ability to read, filter and understand health information in order to form sound judgments"
9	Pavlekovic (2008)	"The capacity to obtain, interpret and understand basic health information and services and the competence to use such information to enhance health"
10	Rootman & Gordon-Elbihbety (2008)	"The ability to access, understand, evaluate and communicate information as a way to promote, maintain and improve health in a variety of settings across the life course"
11	Ishikawa & Yano (2008)	"The knowledge, skills and abilities that pertain to interactions with the healthcare system"

12	Mancuso (2008)	"A process that evolves over one's lifetime and encompasses the attributes of capacity, comprehension, and communication. The attributes of health literacy are integrated within and preceded by the skills, strategies, and abilities embedded within the competencies needed to attain health literacy"
13	Australian Bureau of Statistics (2008)	"The knowledge and skills required to understand and use information relating to health issues such as drugs and alcohol, disease prevention and treatment, safety and accident prevention, first aid, emergencies, and staying healthy"
14	Yost et al.(2009)	"The degree to which individuals have the capacity to read and comprehend health-related print material, identify and interpret information presented in graphical format (charts, graphs and tables), and perform arithmetic operations in order to make appropriate health and care decisions"
15	Adams et al.(2009)	"The ability to understand and interpret the meaning of health information in written, spoken or digital form and how this motivates people to embrace or disregard actions relating to health"
16	Adkins et al.(2009)	"The ability to derive meaning from different forms of communication by using a variety of skills to accomplish health-related objectives"
17	Freedman et al.(2009)	"The degree to which individuals and groups can obtain process, understand, evaluate, and act upon information needed to make public health decisions that benefit the community"
Sørensen *et al. BMC Public Health* 2012 12:80 doi:10.1186/1471-2458-12-80 Permission to reproduce the table was received from the Author (See Appendix A)		

Table 2: Other Definitions from (Berkman, Davis, & McCormack, 2010, pp. 14-15)

Reference (Year; Page)	Definition
Bernhardt, Brownfield, & Parker in Schwartzberg et al., (Ed.) (2005)	An individual-level construct composed of a combination of attributes that can explain and predict one's ability to access, understand, and apply health information in a manner necessary to successfully function in daily life and within the healthcare system. Functional health literacy: the skills and ability to successfully function and successfully complete health related tasks. Individual-level attributes include abilities in prose, document, and quantitative literacy; ability to engage in two-way communication; skills in media literacy and computer literacy; motivation to receive health information; and freedom from impairments and or communicative assistance from others.
Baker (2006)	"The ability to function in the healthcare environment depends on characteristics of both the individual and the healthcare system. An individual's health literacy is context specific (dynamic) and may vary depending upon the medical problem being treated, the healthcare provider, and the system providing care. The definition includes health knowledge".
Nutbeam (2006)	"Personal, cognitive, and social skills that determine the ability of individuals to gain access to, understand, and use information to promote and maintain good health. These include such outcomes as improved knowledge and understanding of health determinants, and changed attitudes and motivations in relation to health behaviour, as well as improved self-sufficiency in relation to defined tasks. Typically these are outcomes related to health education activities. Health literacy is conceptualised as one domain in a conceptual model of health promotion".
Healthy People (2010)	"Dependent on individual and system factors, including communication skills of lay persons and professionals, lay and professional knowledge of health topics, culture, the demands of the healthcare and public health systems, and the demands of the situation context".

The first definition of health literacy was provided by WHO in 1998, then almost ten years later, (Baker, 2006) indicated that there was a lack of shared meaning of understanding for health literacy and provided a better meaning with dimensions to measure the need for functional health literacy. The definitions given by Nutbeam (2006) and the Healthy People (2010) report were widely used in many health literacy and oral health literacy studies. A majority of studies in health literacy used the Institute of Medicine's definition. Berkman et al., (2010) indicated that there is a need to review the existing definitions and the importance of evaluating the answer to the question "What is Health Literacy?".

Berkman et al., (2010) modified the Institute of Medicine's (2004, p.16) definition to "The degrees to which individuals can obtain, process, understand, and communicate about health-related information needed to make informed health decisions". In Berkman's definition, "capacity to" from the Institute of Medicine's definition (2004) (see Table 2) changed to "can". Berkman et al., (2010) also note that the definition of health literacy adopted may depend on one's goal. The Australia Bureau of Statistics (2008) definition was adopted for the current study as I interpret health literacy as an ability to live in a healthy manner.

None of the above definitions or studies explored the meaning for health literacy which indicated the "degree of interest" in seeking healthcare information as an important factor for achieving health literacy. Peter (2000) writes that social psychologists note that there are different stages (see Figure 1) through which an individual passes when adopting new ideas and practices and where interest plays an important role. In India, both Government and media have been publishing and disseminating much health information but most of it was not seen by the public (Murugan, 2008; Parkash, Duggal, & Mathur, 2004). This might be because of a lack of interest in health information and hence, without an individual paying attention, it is difficult to provide information for the target audience who are not receptive. Interest in acquiring health knowledge must therefore be added to the process of achieving health literacy (See Figure 2).

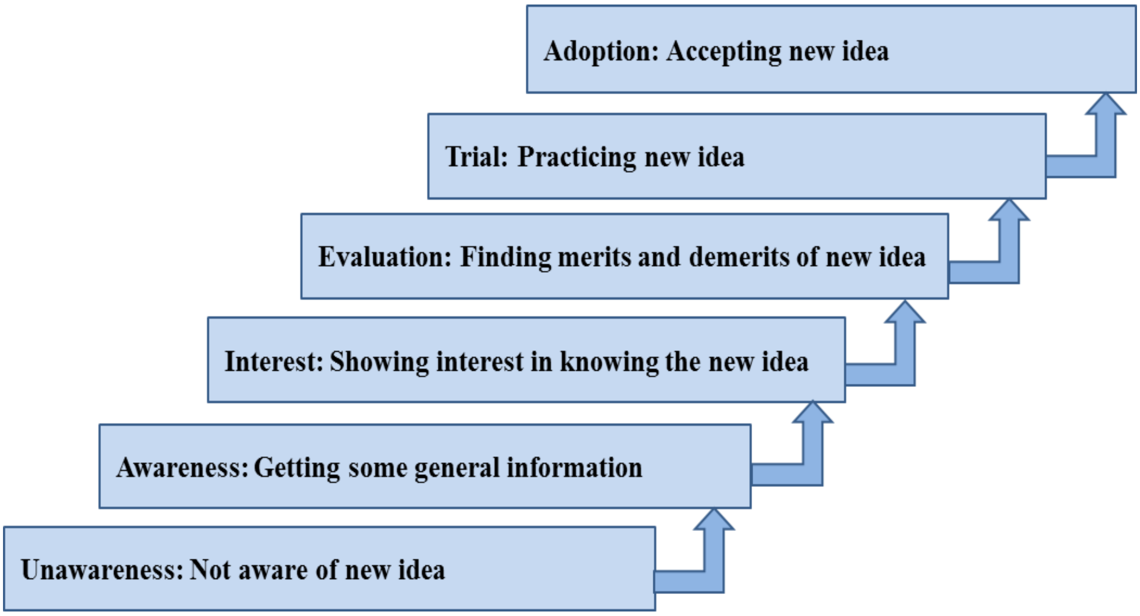

Figure 1: Process of Adopting New Ideas (Peter, 2001)

From the definitions above, the diagram below has been developed to provide an overarching guiding framework of health literacy for the current research and also to inform the development of an oral health literacy questionnaire for use in this research project.

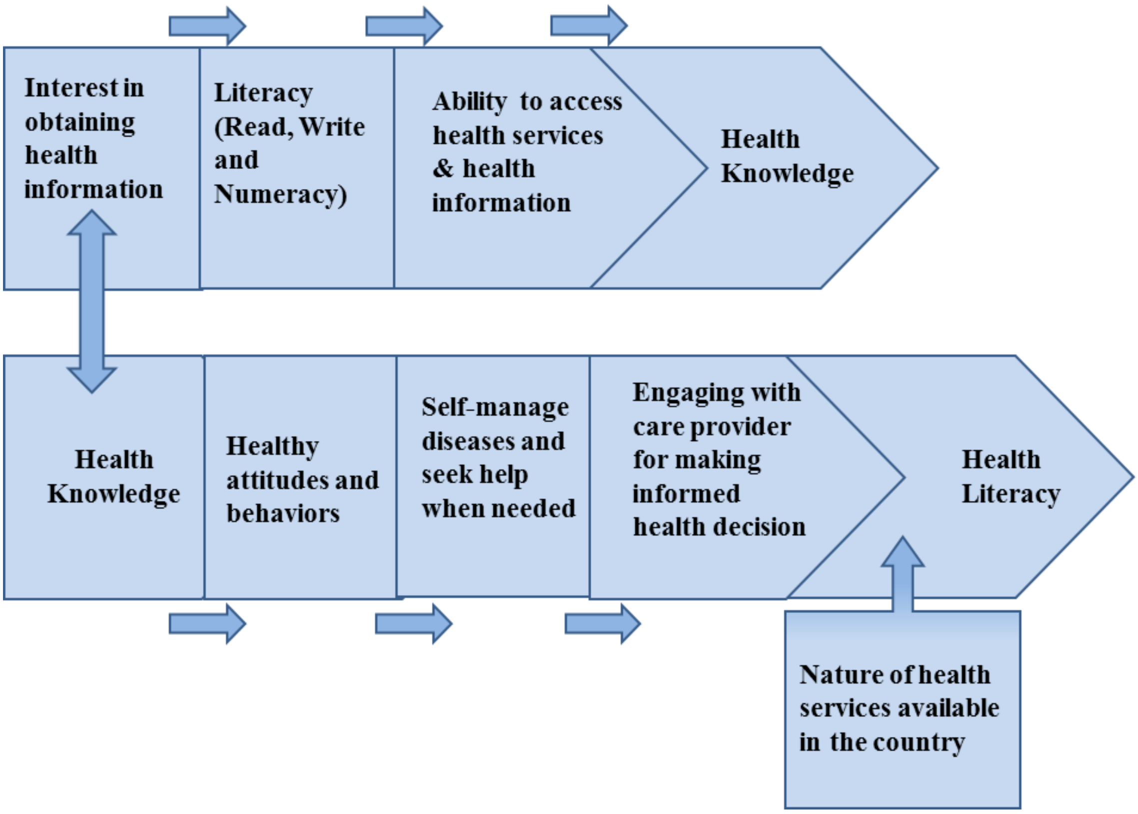

Figure 2: Process of Obtaining Oral Health Literacy

The process of achieving oral health literacy includes (See Figure 2):

- A person with general literacy, an interest in achieving good health, and the ability to access health information is expected to acquire an increased level of health knowledge (Veerasamy & Kirk, 2014).

- Basic health knowledge will possibly increase the interest in receiving health information. At the same time, interest in getting health information is expected to increase their health literacy (Veerasamy & Kirk, 2014).

- Health knowledge will help an individual to participate in shared-decision making in healthcare situations and by participating in shared-decision making, the existing level of health knowledge is expected to be increased with the help of healthcare providers (Veerasamy & Kirk, 2014).

Thus, a person with a high level of health literacy is more likely to have healthy behaviours and attitudes, and able to self-manage diseases, and participate well in shared-decision making.

1.2.1.2 Health literacy and Child health outcomes

Adolescents' health literacy and the associated health outcomes have been less comprehensively studied compared to adult contexts. A systematic review by Dewalt and Hink (2009) identified 4335 articles relevant to health literacy and found only 13 articles that addressed health literacy on child health outcomes. Those 13 studies identified an association between low health literacy and tobacco usage (Hawthorne, 1997), behaviour issues (Stanton, Feehan, McGee, & Silva, 1990), use of non-standardised medication dosing (Yin et al., 2012), severe asthma (DeWalt, Dilling, Rosenthal, & Pignone, 2007; Rosas-Salazar, Apter, Canino, & Celedón, 2012), more frequent medication use (DeWalt et al., 2007), and making a habit of missing school (DeWalt et al., 2007). Ross et al., (2001), however, identified no association between health literacy and glycaemic control among 5-17 year olds but did note a relationship between maternal health literacy and glycaemic control in children.

The association between a lower health literacy of parents and poor child health outcomes has been well documented (Modi et al., 2012; W.F Vann, Divaris, Gizlice, Baker, & Lee, 2013). One study by (Kaufman, Skipper, Small, Terry, & McGrew, 2001) indicated a positive association between little or no breast feeding and low health literacy. None of the earlier studies identified the key role that oral health literacy plays in adolescents; some self-management skills and better understanding of health are expected when a child enters the transition from childhood to adolescence. The current study is intended to measure oral health literacy in the adolescent age group to understand the oral health literacy skills they have acquired in childhood. The importance of oral health knowledge for children/adolescents has been demonstrated in various relevant researches. The current study has investigated the importance of adolescent's basic oral health knowledge, oral health behaviour, oral health attitudes, reading comprehension, and self-managing skills. There have been few studies conducted in measuring children's oral health knowledge and behaviour in Indian literature, but the concept of health literacy is slightly different from the concept of their health knowledge. In the current study, the association between oral health literacy and the severity of adolescents' dental caries was also identified.

1.2.2 Dental Caries

Sturdevent et al., (1994) noted that: "Dental caries is the infectious microbiological disease of the teeth that results in localized dissolution and destruction of the calcified tissues" (Sturdevent et al., 1994). A caries lesion only occurs under a mass of bacteria capable of producing a sufficiently acidic environment to demineralise the tooth. The availability of sugar greatly stimulates the bacterial metabolism and acidic foods also decrease salivary and plaque pH which together worsen the microbiological demineralization (Sturdevent et al., 1994).

Dental caries are initiated from an ecological imbalance in the physiological equilibrium between tooth minerals and oral microbial biofilms**.** The biofilms consist of micro colonies of bacteria encapsulated in an organic matrix of proteins, polysaccharide and DNA secreted by the cells (Selwitz et al., 2004). The DNA in the biofilms provides protection to bacterial colonies by enhancing the resistance to antimicrobial agents. The weak organic acids such as lactic, formic, acetic and propionic acids are produced by microbial colonies from fermentable carbohydrates (da Silveira Moreira, 2012b). The weak acid produced will decrease the pH of saliva below seven and cause demineralisation of the hard tooth structure (Selwitz et al., 2004). This demineralisation can be reversed by intake of calcium, phosphate and fluoride in the diet. The rebuilding of the tooth structure results in flurohydroxy apatite crystals. Unavailability of fluoride crystals near the demineralised tooth structure results in cavitation of the tooth structure, which is commonly known as a tooth cavity (Selwitz et al., 2004). In this process, decreasing the fermentable carbohydrates to bacterial colonies and increasing the continuous availability of fluoride will influence prevention of dental caries. Understanding the importance of prevention, following an optimal diet and self-managing by early detection are considered oral health literacy skills with regards to understanding dental caries; these are measured among school students in the current study.

Dental caries can be prevented by removing plaque, using oral hygiene procedures, and by having healthy food habits. For example, Table 3 shows the methods of caries treatment through the standard medical model (Sturdevent et al., 1994) which mostly involves prevention of dental caries by modifying the oral health behaviour of the patient. In Table 3 the majority of prevention procedures can be carried out by the patient and only five of them need a health provider’s assistance or community intervention. Dental caries is preventable and oral health can be enhanced by an individual’s oral health literacy. Thus, the current research was based on preventing dental caries by giving priority to improving the individual’s oral health literacy.

According to the (World Health Organisation, 2006), worldwide, most children and an estimated 90% of adults have experienced dental caries, with the disease most prevalent in Latin American countries, the Middle East and South Asia, and least prevalent in China.

Table 3: Standard Medical Model for Dental caries (Sturdevent et al., 1994)

Methods	Techniques	Prevention by one- self	Oral health providers
1. Limit substrate	• Eliminate sucrose from between-meal snacks	X	
	• Substantially reduce or eliminate sucrose from meals	X	
2. Modify microflora	• Bacterial mouth rinse	X	
	• Topical fluoride		
	• Antibiotic treatment	X	*
3. Plaque disruption	• Brushing	X	
	• Flossing	X	
	• Other oral hygiene aids as necessary	X	
4. Modify tooth surface	• Systemic fluorides	X	*
	• Topical fluorides	X	*
5. Stimulate saliva flow	• Eat non-cariogenic foods that require lots of chewing	X	
	• Sugarless chewing gum		*
	• Medication to stimulate salivary flow	X	
6. Restore tooth surface	• Restore all carious lesions		*
	• Seal pits and fissures		*

Figure 3 shows the DMFT in 12 year-olds all over the world in 2003. It shows that Australia, China, Africa and Greenland had a very low score on the DMFT index. Brazil, Russia, and Mexico are grouped under the moderate DMFT index. The Philippines, Bolivia, and Austria have a very high DMFT index. The United States of America, Canada, New Zealand, half of Africa, the majority of Asian countries such as Indonesia, Japan, Korea, India, Thailand and Mongolia have a lower DMFT index. These data shows that dental caries in developing countries is lower than in a few developed countries, but that this trend is changing owing to an increase in the availability of sugar rich food in developing countries (Jamieson, Thomson, & McGee, 2004). This argument fits India very well because there has been a tremendous change in life styles and this includes an increase in diets rich in sugar, increasing consumption of fast foods and refined foods, owing to the increase in multinational companies based in India (Prabhu & John, 2013). The latest multi-centric study in India (2007) shows a DMFT index between 2.0-3.8 whereas the map indicates 1.2-2.6 (2003), which shows there is a significant difference between those two data sets over even such a short period of time. This indicates a rate of increase in the DMFT index in parts of India from 2003-2007.

The number of cases has decreased in some developed countries such as Australia, New Zealand and the United Kingdom, and this decline is usually attributed to increasingly better oral hygiene practices (Caufield, 2005) and preventive measures such as fluoride treatment (World Health Organisation, 2006). Nonetheless, countries that have experienced an overall decrease in cases of tooth decay continue to have a disparity in the distribution of the disease within a country (Caufield, 2005).

In the United States, dental caries is the most common chronic childhood disease, and is at least five times more common than asthma (Lenaghan, 1992). Dental caries is the primary pathological cause of tooth loss in children and between 29% and 59% of adults over the age of 50 experience caries (Caufield, 2005).

The prevalence of dental caries has been brought under control in many developed countries during the last three decades. This has been achieved through community or school based organised primary preventive programmes. At present, India is passing through the same phase as developed countries did in the 1970s. A number of epidemiological surveys carried out in India indicate that caries is still fairly prevalent and is a major public health problem.

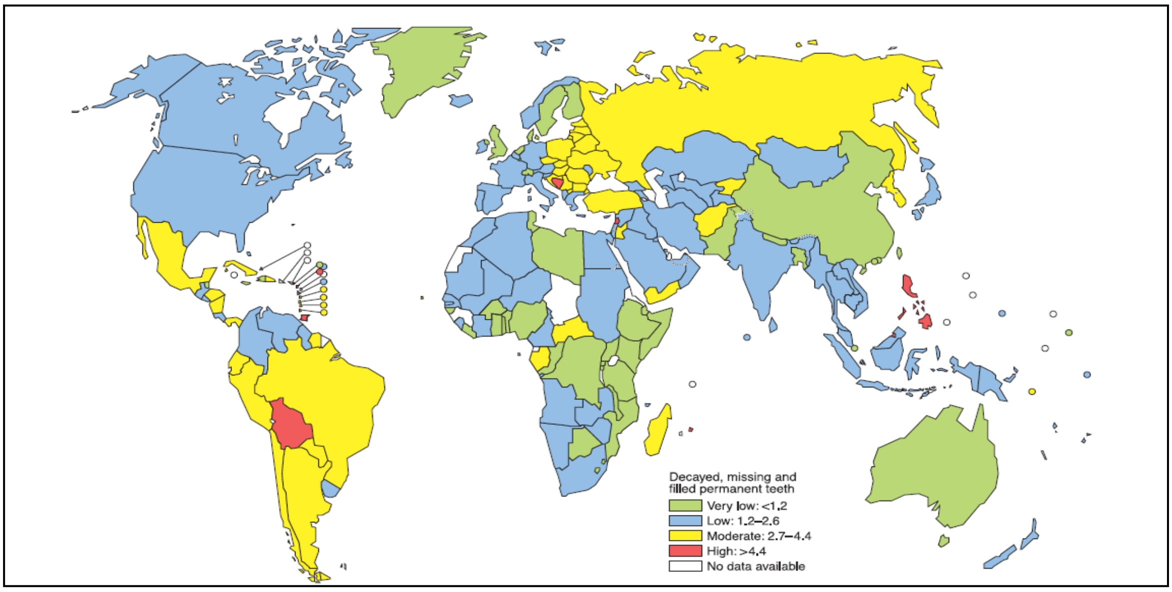

Figure 3: DMFT in 12 year-olds all over the World in 2003 (World Health Organisation, 2003)

Source: ©World Health Organisation, 2003 (See Appendix C)

1.2.3 India

India is the largest democracy in the world covering an area of 1/7th of the world. A Census conducted in 2011 covered 28 states, 8 Union Territories, 640 districts, 5,924 sub-districts, 7,935 towns and 640,867 villages. India is the second most populous country in the world with over 1.2 billion people (Ministry of Statistics, 2012). The Indian economy is the world's largest economy by nominal GDP and by purchasing power parity. India is considered a newly industrialised country and one of the fastest growing major economies. It has the third largest standing army with nuclear weapons and regional power; however, it continues to face the challenges of poverty, illiteracy, corruption and inadequate public health (Andrus & Roth, 2002).

1.2.3.1 Indian Healthcare System

Healthcare in India is still under various stages of development with differences in standards and delivery systems between regions and states (Parkash et al., 2004). One of the reasons for not having a centralised common healthcare system is that there are 22 official languages and 1576 languages and dialects (of those nearly 150 languages have more than a million native speakers and almost every dialect has more than 10,000 speakers).

For general healthcare, every district has community health development blocks, primary health centres, sub centres and village health centres providing free health services to the community, including preventive, promoting and curative services for everyone who prefers to use Government health services (Parkash et al., 2004).

Although there are a large number of Government hospitals, inadequate services have meant an increase in the private sector (De Silva-Sanigorski et al., 2010). The private health sector is further divided into not-for-profit and for-profit organisations. Roa (2012) indicated that 70% of urban and 63% of rural households utilise private medical sectors in India (Roa, 2012).

The expansion of the private sector, however, leads to increased inequality in access to health services. The poor and underprivileged are not be able to afford the costs of the private hospitals. Figure 4 indicates the structure of the public healthcare system which delivers services to 28 different states which comprises 640 districts. Figure 4 outlines the size of the population at each community block, primary care and sub centres separately.

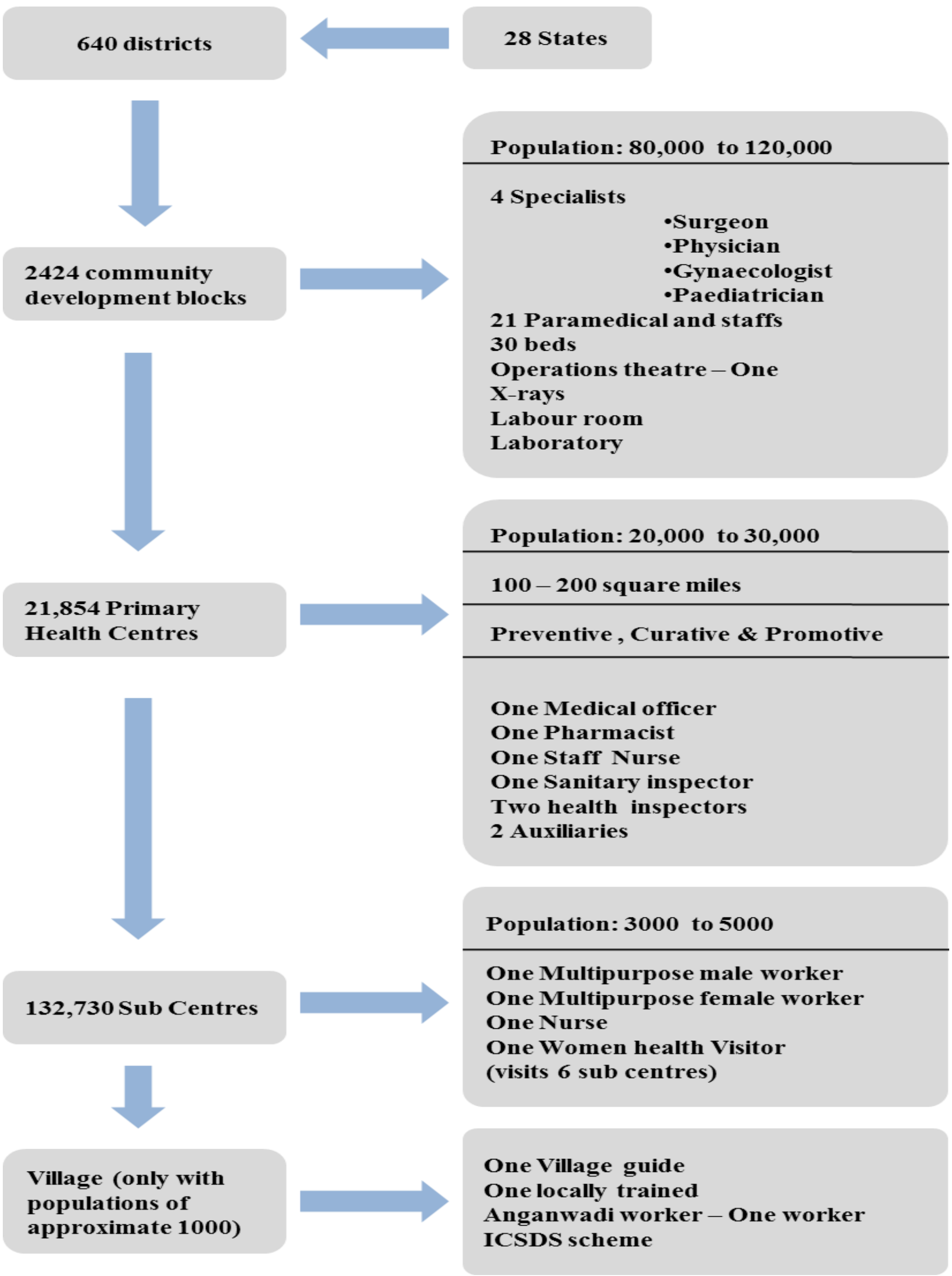

Figure 4: Structure of Indian Public Healthcare System (Murugan, 2008)

1.2.3.2 Indian Oral Health Sector

Oral healthcare is not very well organised in India as general health. Oral healthcare in India is delivered mainly by the establishments shown in the figure 5 (Parkash et al., 2004). Murugan (2008) argues that in India there is a lack of knowledge and education about dental problems. Oral health services are not available for almost 98% of rural areas. The dentist to population ratio is 1:10,000 in urban areas whereas it drastically increases to 1:150,000 in rural areas. According to WHO, the ideal recommended dentist to population ratio is 1: 7,500 (World Health Organization, 2008). Hence, India fails to meet this WHO guide in either urban or rural areas. As per the Government's data portal website, 111,825 dentists are currently registered with their state medical council. Of that number, 95% of dentists work only in private practice which indicates that the majority of the population depend on private dental clinics to deliver oral healthcare.

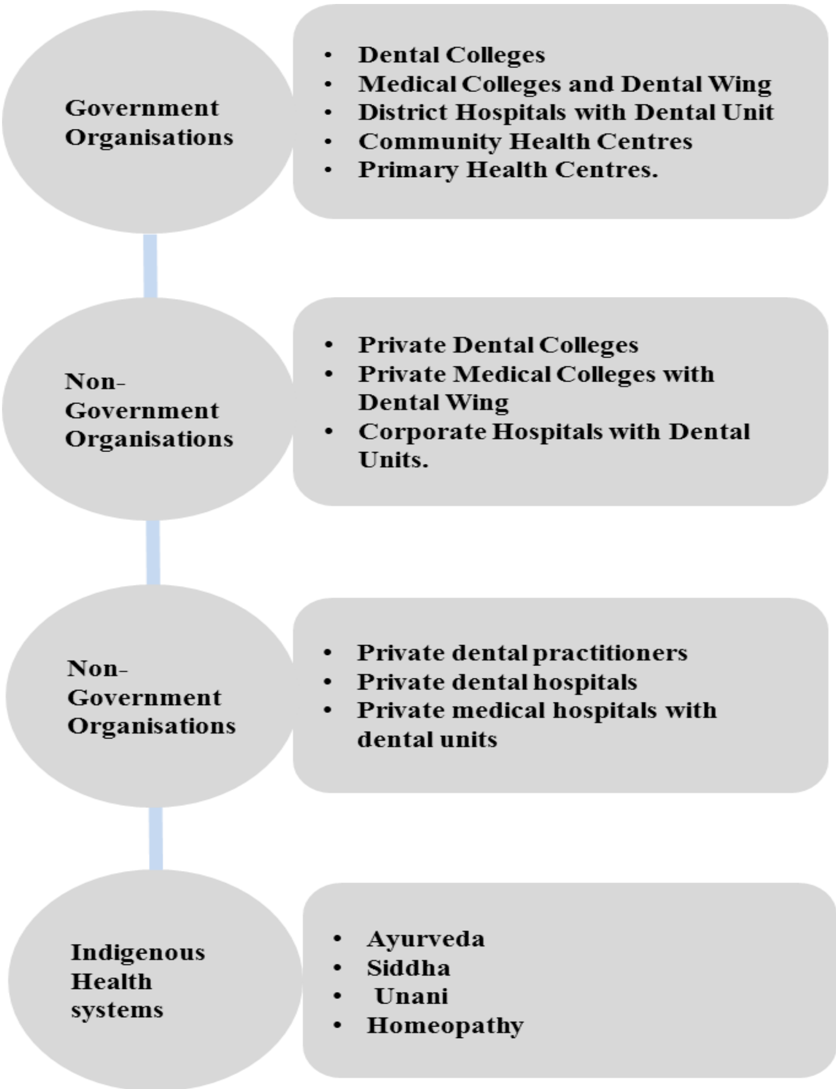

Figure 5: Indian Oral Healthcare System (Parkash et al., 2004)

Even though dental care is considered a part of primary healthcare in India, dental care services are available in only a few states at the primary healthcare level: Tamil Nadu is one of those states. In addition, patients are not covered by any type of insurance, and generally they have to pay out of their pockets to get treatment from either public or private dentists (Tandon, 2004). In regions where acceptable staff numbers are available and services are provided for free to the population, many in the population do not use the available services, so inequalities between different socioeconomic classes remain the same (Singh & Purohit, 2012). Moreover, even the most basic oral health education and simple interventions like pain relief and emergency care for acute infection and trauma are not available for the majority of the population, especially in rural areas. Oral health services are not available in almost 98% of rural areas (Murugan, 2008) which is where 70% of India’s population live.

Over the last five decades, the number of patients with oral diseases such as dental caries, periodontitis, malocclusion, and oral cancer have been increasing in India (De Silva-Sanigorski et al., 2010). This is because of changing life styles, including diets rich in sugar, increasing consumption of fast foods and refined foods, poor oral hygiene, consumption of tobacco, betel nuts, quid and pan masala as well as the increased consumption of alcohol. In spite of this, the Government of India allocates less funding to the dental sector, because it does not consider it a high priority sector, which translates into a lack of knowledge and awareness on oral health issues among the general population. Murugan (2008) argues that the dental health planners in the Indian Government decision making bodies do not have proper training or qualifications and this would be one of the reasons behind the weak public oral healthcare system in India.

1.2.4 Tamil Nadu State

The participants for the current study were recruited from Tamil Nadu, India (Appendix B). Tamil Nadu is the eleventh largest state by area and the sixth most populous state in India. It is the third largest contributor to India's GDP and ranked third in the Human Development Index as of 2011 (Organization for Economic Cooperation Development, 2011). Tamil Nadu performed reasonably well in terms of literacy growth during the decade 2001–2011 (Organization for Economic Cooperation Development, 2011). The state's literacy rate increased from 73.47% in 2001 to 80.3% in 2011 which is above the national average. A survey conducted by the Assocham Industry body, ranks Tamil Nadu top among Indian states with about 100% Gross Enrolment Ratio (GER) in primary and upper primary education (India Edunews, 2008).

The Midday Meal Scheme is the popular name for the school meal programme in India which started in the 1960s and is the largest school lunch programme in the world covering 120 million children (Organization for Economic Cooperation Development, 2011). It involves provision of lunch free of cost to school-children under 14 year-old on all school working days. The key objectives of the programme are: protecting children from classroom hunger, increasing school enrolment and attendance, improving socialisation among children belonging to all castes, and addressing malnutrition (Ministry of Human Resource Development, 2013b). The success of this scheme is illustrated by the tremendous increase in the school participation and completion rates in the state of Tamil Nadu. The literacy rate in Tamil Nadu, when the British left India in 1947, was 12% and by 2011 it had increased to 80%. In 2009, in Tamil Nadu, education became compulsory until the age of 14 (Department of Education, 2010). Some 15 year olds leave the schools from economic necessity to support their family and it was assumed their oral health status might be worse than their peers still at school, and therefore the oral health status for 15 year olds in our sample might be better overall than those not in schools. The schools are considered as the best place to recruit participants 12-15 years, even though 15 year olds in the sample were not representative of the total number of 15 year-olds in Tamil Nadu.

1.2.4.1 Healthcare System in Tamil Nadu

Within India, Tamil Nadu has a better oral healthcare system compared to other states in India. Tamil Nadu has the lowest percentage of population falling into poverty from medical costs in India since 1995. The state has the highest number of health business enterprises in India. Urunguchi et al., indicated that both health awareness and greater healthcare usage as a reason behind most advanced health infrastructure in Tamil Nadu when compared to other states in India. Figure 6 represents the healthcare delivery system for the state Tamil Nadu in India.

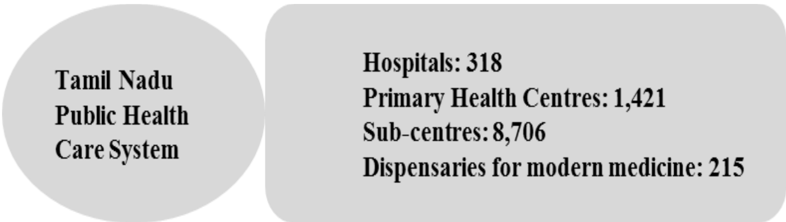

Figure 6: Tamil Nadu Health Sector (Murugan, 2008)

Basu (2012, p. 10) indicated that "Every state in India has its own story of successes and failures in the public health sector. However, Tamil Nadu leads the way in transformation of its public health system and is far ahead of others in the totality of its innovations in the health sector. Therefore the Tamil Nadu model has gained respectability and recognition in Government circles and can be discussed as a possible role model for a National Health Policy and scheme for universal coverage of healthcare". Basu (2012) also indicated that Tamil Nadu health sector is equally well distributed between urban and rural areas and Tamil Nadu healthcare model should be adopted by other states in India to achieve the current millennium goal. Muraleedharan, Dash, and Gilson (2012) indicated in their book “A success story in India” that the four innovative approaches from Tamil Nadu healthcare model, not only for Indian states but also for foreign nations to adopt namely, training a new type of village primary healthcare workers to work round the clock, building a network within primary health centres, scaling up immunisation and the innovative drug delivery system (Selvavinayagam & Vijayakumar, 2012; P. V. Singh, Tatambhotla, & Kalvakuntla, 2012). These innovative approaches have even recognised in international literature (Malaney, 2000). Even though the private healthcare system is rapidly expanding, the joint private-public engagement in Tamil Nadu which includes, health awareness raising campaigns; contracting out the laboratory diagnostics services; corporate support for primary healthcare facilities and health promotion; publicly funded insurance for lower and middle class population has enhanced the overall healthcare delivery in Tamil Nadu. The common drug distribution system and corporate laboratory system made the medical cost 25-30% less than other states which improved the medical tourism in Tamil Nadu. The Government has identified 25 city private hospitals and established an exclusive medical tourism department which is organised by trained health professionals to provide a high quality and standardised healthcare for foreigners and this approach has added value to medical tourism in Tamil Nadu (Murugan, 2008). The Government of India has indicated that other states in India ought to emulate Tamil Nadu model to enhance medical tourism in India. Chennai is the epicentre for dental tourism in Tamil Nadu which offers implant, veneers and dental cosmetic treatments for 70% cheaper cost when compared to western countries without compromising the quality (Murugan, 2008).

1.2.4.2 Oral healthcare in Tamil Nadu

The rural oral healthcare scheme was implemented in Tamil Nadu after 2004. By 2008, 32 primary health centres had started to provide scaling, filling and extraction for free. The scheme was strengthened and in the year 2012-2013 360 primary health centres provided free oral health treatment for all age groups.

Tamil Nadu is the most urbanised state in India: 44% of the total population live in urban areas (Sharma & Zodpey, 2011). Private dental institutes are located in seven districts of Tamil Nadu, and they provide free or inexpensive services to improve the quality of dental education. In rural areas, primary health centres offer dental services such as prophylaxis and emergency services for three days a week.

Between independence and the 2002 National Oral Health Survey conducted by Dental Council of India, India did not collect oral health status data based on uniform assessment criteria (Parkash et al., 2004). In 2007, the WHO in collaboration with the Government of India conducted a further multi-centric study involving seven states and 22,400 people in rural and urban areas and compared oral healthcare needs in different states of India. Because of resourcing issues, the State of Tamil Nadu was not included in that study (Shah et al., 2007). At present, therefore, recent accurate baseline data are not available to understand the prevalence of dental caries among adolescents in rural and urban areas of Tamil Nadu to develop effective oral health intervention and prevention strategies.

1.2.5 Indian Caste System

The Hindu caste system began to take shape in 1,000 BC and caste system has persisted in the Indian community for more than 3,000 years. There are four castes in Hindu religion and untouchables or Dalits are a fifth group who historically included foreigners and nomadic tribes (Tamil Nadu Social Development, 2000). The Indian Government divides various caste categories into Forward Caste (FC), other Backward Castes (BC), Most Backward Castes (MBC), Scheduled Castes (SC) and Scheduled Tribes (ST). The Scheduled castes (SC/ST) populations were the official definition given to various caste categories that are historically disadvantaged in the Indian community. For thousands of years Dalits were not given rights to study and own property, until the 1950 National Constitution of India legally abolished the practice of “untouchability” but the practices still exist in many rural parts of India (Tamil Nadu Social Development, 2000). A report from Social Development Departement indicated that the death rate and infant mortality among dalits (SC/ST) compared to non dalits was comparitively higher. The status on dalits oral health compared to non-dalits is not available in either Tamil Nadu or Indian literature. A study by (Devi & Babu, 2011) in four districts of Tamil Nadu indicated that the dalit communities suffer from various communicable diseases because of a lack of hygine measures because they have been living in a vulnerable socioecominc status for many centuries. Hence, in the current study it was assumed that their oral health would be poor compared to other caste communities and data relevant to community/caste categories was collected. There are various policies in India to enhance Scheduled Caste’ and Tribes’ health, education, social status and economic status, but there are no polices that focus in particular on the Scheduled Caste and Tribes population in regard to oral health. The current study results would be useful for Tamil Nadu government to implement oral helath policies focusing on the dalit population’s oral health outcome.

In the current study, the current level of oral health literacy among school students was measured. The results were correlated with prevalence and severity of dental caries in the adolescent population. The results will help to inform the level of intervention needed to implement oral health literacy education in Tamil Nadu schools. The relevant studies reviewed and are presented in the next chapter.

Chapter 2: Literature Review

2.1 Chapter Introduction

In this chapter, studies of literature relevant to the current thesis are presented. First, the process of reviewing the literature is explained and then the studies that have been reviewed are presented in the context of the research questions. A geographical approach is taken for the first research question, on dental caries, and a thematic approach is taken for the oral health literacy studies. A review summary concludes the chapter (see Figure 7 for a diagrammatic outline of the structure of the chapter).

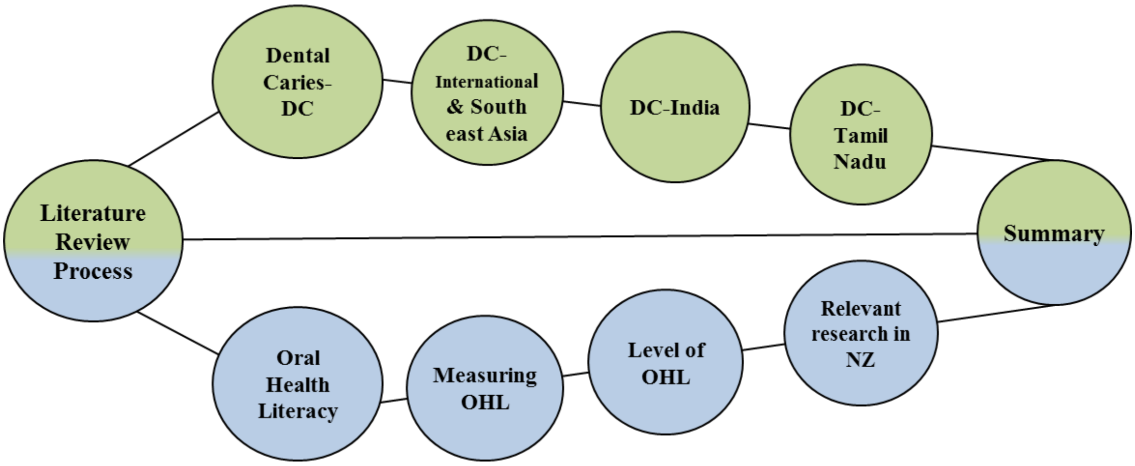

Figure 7: Structure of Literature Review Chapter

2.2 Overview of Literature Review Process

The context for reviewing the literature was based on understanding the prevalence of dental caries in the Indian adolescent population, the concept of oral health literacy and its effect in preventing dental caries. A systematic review was performed by dividing the topic into two major sections based on the research questions:

1. What is the prevalence of dental caries in 12 -15 year old school students in Tamil Nadu?

2. What is the oral health literacy of adolescents living in rural and urban areas of Tamil Nadu?

For each topic what has been published, its significance to the current study, trends in methodologies, appropriate analysis relevant to the study and gaps in the literature are outlined.

The literature review was conducted using the following bibliographic databases: Medline, Pubmed, Web of Science and the Cochrane Library. The following Internet searches were undertaken: Google, Google Scholar, Health Department, Education Department, Indian Dental Council and Tamil Nadu Dental Council websites of India.

In this chapter, 41 articles are analysed and these are presented in two sections, namely: dental caries and oral health literacy. Figure 8 indicates the number of articles selected for the review for the first and the second research questions.

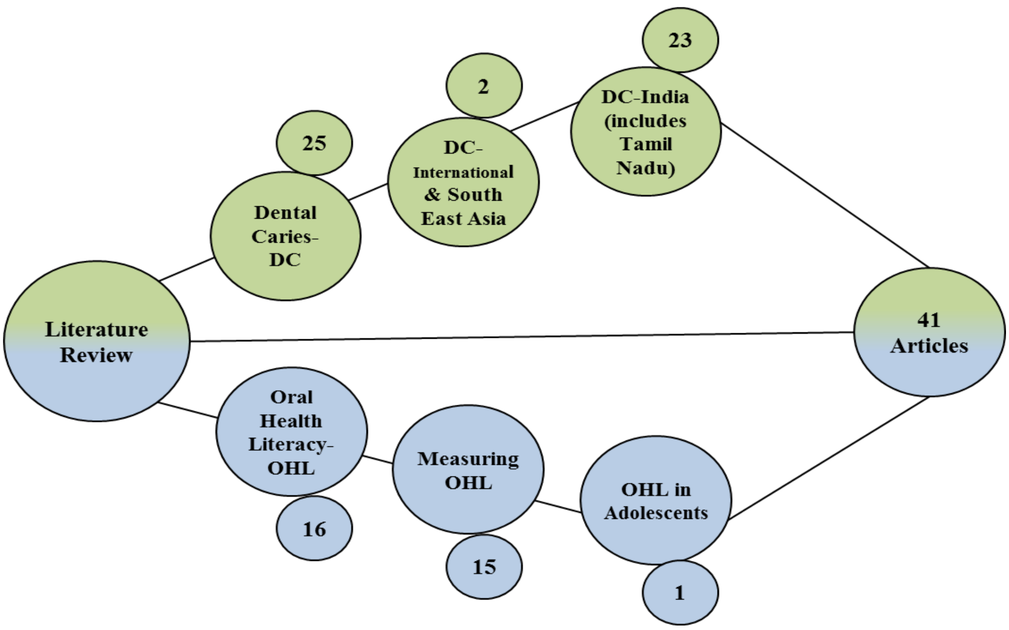

Figure 8: Number of Articles Reviewed in the Current Thesis

2.2.1 Overview of Literature Review Process for Research Question 1

What is the prevalence of dental caries in 12-15 year old school students in Tamil Nadu?

The literature was reviewed to understand the current prevalence rate and severity of dental caries for different countries and regions in India, including Tamil Nadu.

2.2.1.1 International literature

The review of articles for the first research question was intended to place the Indian research in context. Hence, to understand the DMFT average and prevalence percentage for different countries in the world, only the systemic review studies were searched for the terms “dental caries”, “prevalence”, “severity” and “adolescent” which resulted in 19 articles. In 19 articles, only two studies were identified as relevant to the current study. These two studies have included sufficient information required to understand the dental caries status of 190 countries in the world. Figure 9 indicates the process of literature review for first research question.

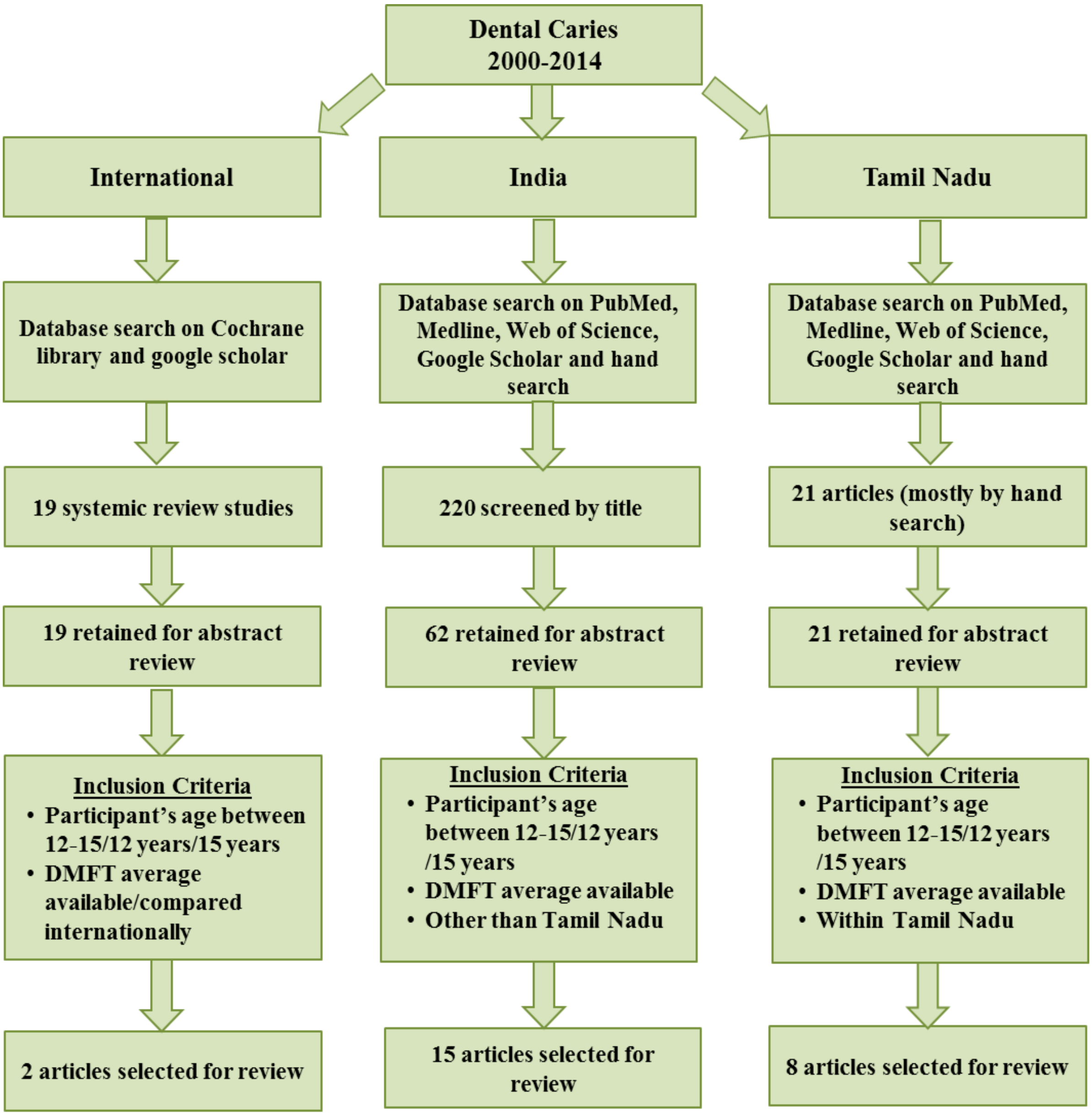

Figure 9: Process of Literature Review for dental caries studies

2.2.1.2 Indian studies

For Indian studies, the search terms "prevalence of dental caries in children/adolescent", "DMFT in children/adolescent", "severity of dental caries in children/adolescent", treatment needs in children/adolescent", "oral health status of children/adolescent", and "epidemiology of dental caries in children/adolescent" were used. All published studies conducted of the adolescent age group between 2000 and 2014 were chosen for literature review. The prevalence of dental caries and DMFT average available for Indian states and Union Territories of India were analysed and these are discussed in chronological order.

All studies available for the adolescent age group published after the year 2000 were reviewed and grouped into five geographical categories, namely: North, South, West, East and central India. The studies conducted in Union Territories are discussed separately. In total, 15 Indian studies were reviewed.

The WHO determined 12 year-olds to be the standard age group for global monitoring of dental caries from oral health surveys (da Silveira Moreira, 2012b) and therefore, studies conducted among 12 year olds are most common in the literature and were available for most Indian states. For this reason, most of the studies discussed in this section used samples with age groups between 12 and 17 years.

2.2.1.3 Tamil Nadu Studies

A separate literature search was conducted for Tamil Nadu with the same search terms indicated previously for Indian studies by including "Tamil Nadu" in the search. In total, eight studies were identified for Tamil Nadu and this includes two studies conducted in Chennai.

A systemic approach was used to review the studies: prevalence and severity of dental caries identified in each study, the reasons for unusual results, and the strengths and limitations of the methodological approaches were presented for each study.

The selected studies were evaluated to address the following questions:

- What is the aim of the study?
- Are standard methods followed for population selection? Is the population studied appropriate? Are inclusion and exclusion criteria explained?

- What is the type of caries index is used to measure prevalence and severity of dental caries? (example: DMFT index, DMFS index)
- Does the study follow standard WHO protocols?
- Is the choice of method appropriate for the study aim?
- Were the assessors blinded to the different groups, if this were deemed necessary?
- What are the results? Are prevalence and DMFT averages relevant to other studies? If not, is a satisfactory explanation given by the authors?
- Is the author's choice of statistical methods appropriate?

2.2.2 Overview of Literature Review Process for Research Question 2

<u>What is the oral health literacy of the adolescents living in rural and urban areas of Tamil Nadu? (Figure 10)</u>

The search terms used to identify articles were "oral health literacy", "health literacy in oral health" and "oral health literacy in adolescents" and this resulted in 61 articles conducted internationally, 37 articles of which were selected as relevant for review of the abstract. Of these, 15 articles were reviewed to understand how oral health literacy was measured. Figure 10 shows the process of literature review for the oral health literacy studies.

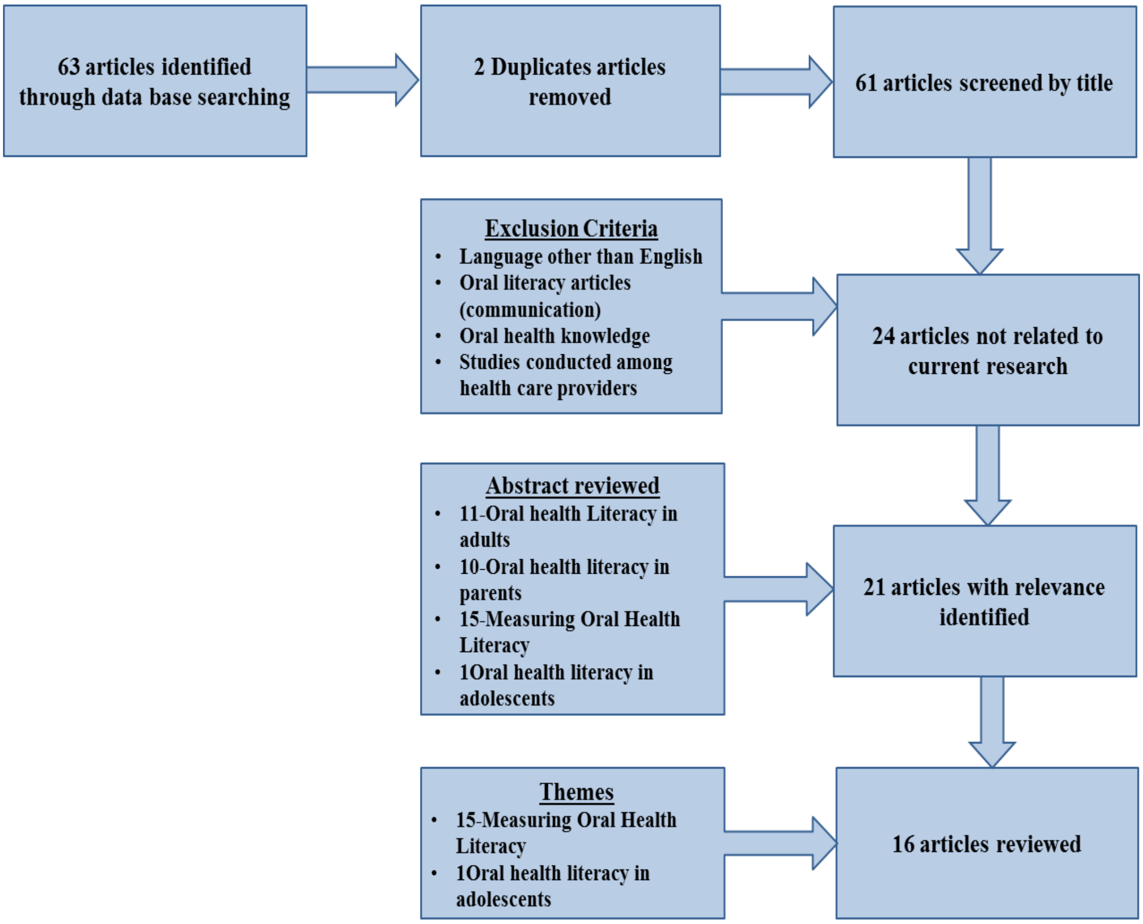

Figure 10: Process of Literature Review for Oral Health Literacy Studies

The relevant articles were reviewed in three stages. First, a preliminary review was conducted to understand the overall framework of each article and relevant studies were grouped based on common elements: namely, studies conducted to measure oral health literacy, studies conducted among the parents/caregivers, studies conducted among adult participants, and studies conducted among adolescents. The abstract review identified 21 oral health literacy studies that were conducted among adults and the parent populations and although those studies were considered not relevant to the context of the current research, the findings of those studies are discussed briefly to highlight the importance of oral health literacy and its association with oral health status. For the final review, 15 studies that measured oral health literacy and one study conducted among adolescents were selected.

In the second stage of the review, the 15 articles were compared to emphasise the similarities and differences between the studies for the following elements: the questionnaires that were used to measure oral health literacy, the meanings of oral health literacy, the study populations, the survey procedures, and the statistical tests used for analysis of the results.

The individual studies were also analysed by a systemic approach to distinguish the methodological qualities such as logical reasoning, assumptions, strengths and weaknesses in the research work. Details of the study design, methods used to collect data, analytical procedures and the authors' conclusions, and the limitations of the studies are described.

The studies were evaluated for:

- Definition and meaning of oral health literacy.
- Structure and conceptual framework for developing the oral health literacy questionnaire.
- Reliability and validity of the questionnaires.
- Length of the questionnaire and any disadvantages associated with the length.
- Structure of questionnaire and items used to measure oral health literacy.
- Strengths and weakness of developed questionnaires as described by the author and its relevance to other studies in the literature.
- Population selected for testing the developed questionnaire.
- How were the individual items scored and how were the final scores calculated?
- How did the studies compare the oral health literacy scores with oral health status?
- Is there an association identified between oral health literacy and oral health quality of life?

2.3 Dental Caries in Adolescents

In this section, studies relevant to the current study as well as those that helped to build the framework for the current study are discussed by geographical location. The relevant research is discussed in four geographical areas: international, South East Asian, Indian, and Tamil Nadu State studies. The section starts with brief discussion on the prevalence of dental caries among adolescents in general, and then the prevalence of dental caries is discussed separately for adolescents in different parts of the world, including a more in-depth analysis for India and Tamil Nadu.

In the current study, prevalence of dental caries among 12-15 year olds was determined by the oral health examination. For this reason, in this section, the prevalence of dental caries for adolescents is reviewed for international, South East Asia, India and Tamil Nadu populations separately.

2.3.1 Dental Caries-International

Marthaler (2004) indicated that the first statistics relating to dental decay were published in 1900 and that most of the studies published at that time aimed at determining oral health status, as well as identifying a caries inhibiting factor for fluorides in the drinking water supply. DMFT rates were considerably reduced in 20th century from more than seven to less than three, which was the target to achieve for 12 year olds by the WHO (Bagramian et al., 2009; da Silveira Moreira, 2012b; Marthaler, 2004). A majority of countries had achieved the WHO target before the target date of 2000 but dental caries is still a serious disease in many countries, particularly in less developed countries that are without any community preventive strategies designed to control the disease. Despite great achievements globally in regards to achieving the target, the WHO (2004) oral health database, country/area profile programme indicated that 200,335,280 teeth in 12 year olds worldwide were DMFT affected. A report from the American Surgeon General (2004) indicated that fifty-one million school hours are lost every year because of dental illness. In both developed and less developed countries, underprivileged groups are most affected (Miyazaki & Morimoto, 1996). The report indicated that inequalities exist between different parts of the world but also in different regions within a country (Miyazaki & Morimoto, 1996). Despite efforts such as fluoridating water supplies, providing school dental services, and other preventive measures for more than 100 years, dental caries is still a major health issue affecting 60% to 90% of school children worldwide (WHO, 2003).

A recent ecological study was conducted in six WHO regions (see Figure 11) with the aim of describing the dental caries status of 12 year-olds in 190 countries. This is part of a WHO project to develop and implement health policy strategies and to predict and prevent future burden of dental caries in both developed and less developed countries. This study included a number of countries that achieved the WHO target on “DMFT average less than 3 for 12 year olds before 2000” (da Silveira Moreira, 2012b) .

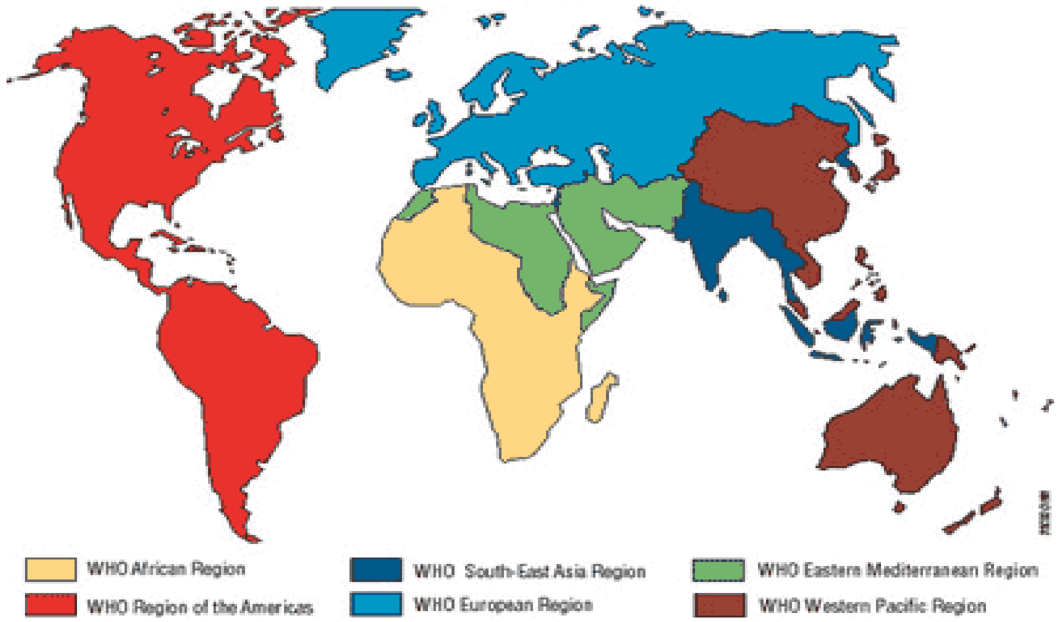

Figure 11 Ecological Study In Six WHO Regions

(Source: © World Health Organisation, http://www.who.int/about/regions/en/ See Appendix C)

Ecological studies use the data of a population group as a unit of observation to measure the rates and exposure of the disease of interest (da Silveira Moreira, 2012b) . This ecological study uses the data available from WHO Oral Health Country/Area Profile Programme website because these data are available for public use. Data are available for the period between 1973 and 2008 for different participating countries and this was used to construct the maps to show the difference between relative risks for each country to an assigned standard mean reference value (Figure 11).

Population Attributable Risk (PAR) is the relative difference between each of the proportional units of analysis and an arbitrary reference value, which in this study refers to the average DMFT of each region.

In da Silveira Moreira (2012b) study, bar charts were presented for each WHO region and within each region the participating countries were listed with values represented by 23 different horizontal bar charts, maps and graphs. Material relevant to the current study is listed in Table-4.

Table 4: Ecological Study on DMFT for Six WHO Regions (da Silveira Moreira, 2012b)

WHO Region	Year of data available	DMFT	Total countries in this region	Total countries-available data	Number of Countries at risk in each region
African	1997-2004	1.7	46	40	6
American	1987-2008	2.4	47	40	11
South East Asia	1984-2008	1.95	11	10	5
Europe	1973-2008	2.3	53	51	24
Eastern Mediterranean	1987-2008	2	21	20	4
West Pacific	1984-2007	1.93	27	24	6

Table 4 suggests that only six African regions are low DMFT risk. European and American regions have DMFT values of 2.3 and 2.4 respectively which were higher compared to other regions (da Silveira Moreira, 2012b). The report concluded that dental decay was a disease of rich countries in the 20th century due to lower DMFT scores in less developed countries especially the African region (Medeiros, Weyne, & Moraes, 2001).

In the South East Asian region, the average DMFT is 1.95 which was slightly lower than American and European regions. The countries in the South East Asian region are amongst the least developed countries and 50% of countries in this region are at risk for dental caries (see Table 4), which suggests that dental decay is not only a disease of rich countries in the 20th century. In the South East Asian region, India is at higher risk with a PAR of 101.84%, which is highest for this region compared to other South East Asian countries. This is important for the current thesis because the values indicate that India is at greatest risk amongst all South East Asian countries even though the economic growth is relatively higher for India when compared to other South East Asian countries. The increase in the country's economic status, westernisation and; changes in diet and food habits increase the burden of dental disease in India. For this reason a better understanding of disease rates in different parts of India should help to improve oral healthcare facilities in India.

Figure 12 shows the severity of dental decay in WHO regions and this shows that Europe, India, parts of the American region and a few countries in African and eastern Mediterranean regions are at higher risk of dental caries compared to other countries (da Silveira Moreira, 2012a). The very low risk countries are Australia, China and the majority of countries from the African regions. The data for African countries are older than other countries which might be one of the reasons for the very low DMFT average. The author indicated the availability of older data as a limitation for the study and also added that a diet based on hunting and subsistence agriculture combined with a low-carbohydrate diet was an explanation for low DMFT rates in the less developed countries.

In this study, only the DMFT percentage for 12 year olds was compared and analysed. The DMFT is calculated by combining the total score of decayed, missed and filled teeth. In the total DMFT score, where the number of decayed teeth outnumbers the filled teeth the population is at risk. For example, adolescents in less developed countries would have the least or no access to oral health services and their DMFT score would mostly relate to the decayed component. In the current study, the decayed component contributed more to the DMFT total score, a point that will be discussed further in the Results chapter. Children from countries like New Zealand or Australia with good oral health services have higher DMFT scores but this is dominated by the "filled teeth" component (Chen & Hunter, 1996; Skinner, Johnson, Phelan, & Blinkhorn, 2013) rather than "decayed but not filled teeth" component of the DMFT score. The availability of oral health services and oral health awareness and the treatment needs determine the level of risk for a country. Future studies could measure

DMFT and also the treatment needs for the study group when compared to developed and less developed countries to understand and group risk populations. In addition socioeconomic variation within countries, the so called social determinants of health, will also influence variation in DMFT scores within countries. This too requires further research.

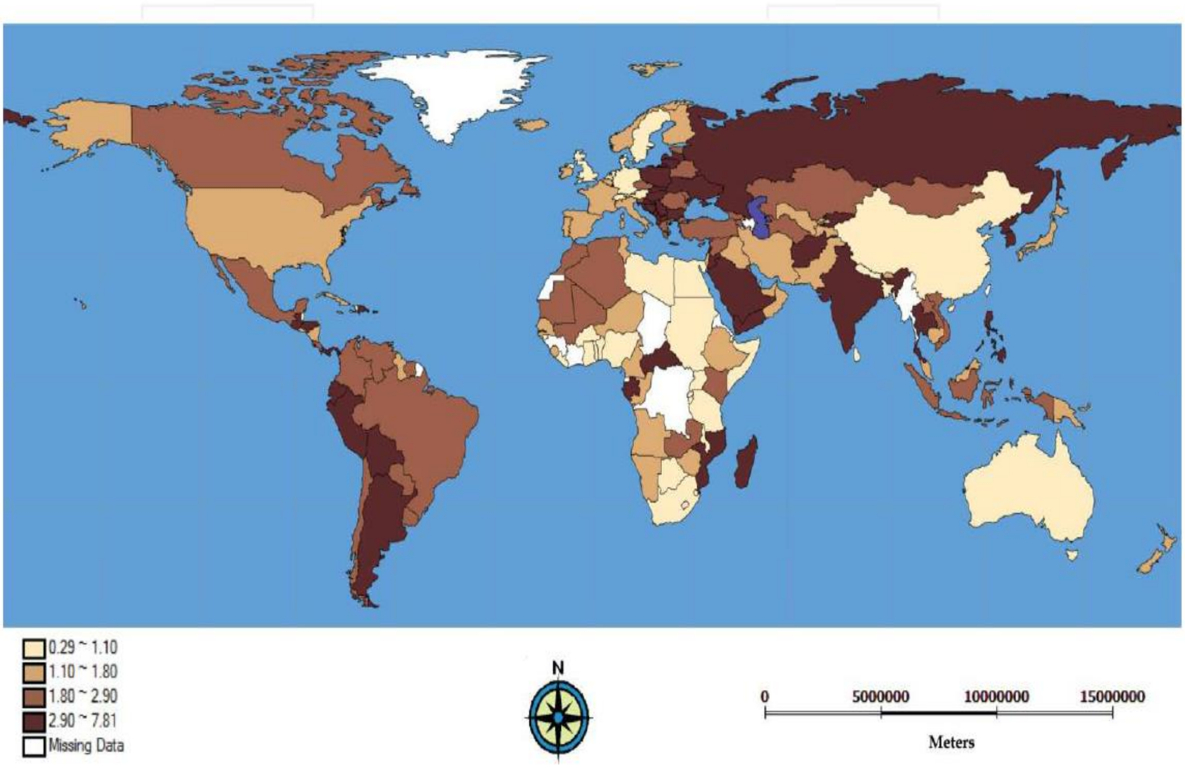

Figure 12: Severity of Dental Caries in the World (da Silveira Moreira, 2012a)

Permission to reproduce the map was received from the Author (See Appendix D)

In the United States of America, at least one cavity or restoration is present in 78% of 17 year-olds. A striking inequality exists between poor and non-poor children is commonly seen in every age group (Bagramian et al., 2009). The intensity of caries is severe in poor adolescent which is serious because their teeth structure is damaged beyond treatment. The continuous USA National Health and Examination Survey (NHANES) from 1988-1994 and 1999-2004 indicate there is no improvement in oral health status and there is no reduction noted in DMFT percentage in the last 10 years since the WHOs “DMFT less than 3 in 12 year-olds” target by the year 2000. The same issues were noticed in a study in countries in Western Europe where DMFT data indicated that prevalence of dental caries decline stopped when the DMFT rate reached low or very low values (less than 3). This study also indicated that dental caries was more prevalent in lower socioeconomic populations and in the immigrant population (Marthaler, 2004). Dental caries is becoming concentrated in fewer children (Poulsen, Heidmann, & Væth, 2001) but those children are from lower socioeconomic backgrounds. This shows that dental caries is predominant as a disease of the underprivileged who live in rich developed countries with accessible sophisticated prevention methods such as community water fluoridation and school dental services. This outcome indicates that availability and accessibility of sugar rich food and one’s oral health awareness plays a major role in prevalence of dental caries. In under developed countries the lower availability of sugar rich food explains the low DMFT ratio. More than indicating the dental caries as a disease of rich countries, it would be more appropriately seen as a disease of the lower socioeconomic population living in developed countries.

New Zealand data suggests that DMFT scores at 12 years are higher for Maori and Pacific Island children compared to European and other ethnic groups (Ministry of Health, 2010a). A greater prevalence of dental caries in indigenous populations is also reported in Australia (Eleanor J Parker & Jamieson, 2010), USA (Warren et al., 2012), Brazil (Alves Filho, Santos, & Vettore, 2014), and Canada (Harrison, Veronneau, & Leroux, 2010). The trends in DMFT scores in different regions of New Zealand indicate that non-fluoridated areas have higher prevalence rates compared to fluoridated areas (M. Lee & Dennison, 2004). That difference is higher for 5 year olds compared to 12 year olds because of less participation in oral hygienic measures in younger age groups. In spite of having uniform public dental services throughout the country, the difference in caries prevalence is significant as a result of water fluoridation. The DMFT scores for New Zealand were classified as a “very low level” assigned by the

WHO. Even though New Zealand has had uniform public oral health services almost for 100 years and the added advantage of water fluoridation in some regions, the DMFT rate is higher among Maori and Pacific Island peoples, which highlights the importance of oral health literacy and diet in preventing dental caries, when combined with water fluoridation.

2.3.2 Dental Caries: South East Asia

As discussed above, international studies indicated growing trends in DMFT scores in developing countries especially South East Asia (Bagramian et al., 2009; da Silveira Moreira, 2012b). The increasing availability of sugar rich and processed food is likely to be the reason behind the change in the pattern of dental caries in developing countries. In South East Asian region, oral health promotion through public health strategies is at a rudimentary stage. The WHO Regional Committee for South East Asia aims to coordinate multisectorial and public health action for member states and to increase commitment of the promotion of oral health and the prevention and control of oral diseases (World Health Organization, 2009). A regional consultation held at Chiang Mai, Thailand, in October 2008 deliberated on the situation of oral health policies and strategies required for setting up public health oriented action (World Health Organization, 2009). The consultation provided important inputs toward the formulation of an oral health strategy for the South East Asian countries. The main objective of this meeting was to formulate a regional oral health strategy and the countries included on that committee were Bangladesh, Bhutan, India, Indonesia, the Maldives, Myanmar, Nepal, Sri Lanka and Thailand.

A report authored by the WHO regional committee in 2008 about oral health status in South East Asian countries was designed to formulate strategies to improve oral health outcomes. As discussed in the previous section the countries in South East Asia had achieved the target for “DMFT below 3 before the year 2000”. That target, however, would not have been achieved by oral health strategic plans and other community oral health promotions in those countries alone; only the nature of their diet made the difference (World Health Organization, 2009). This is discussed further below.

Table 5 shows the oral health status of 12 year-old children in South- East Asian countries. The DMFT index ranges between 0.5 and 2.2 which is not too high compared to other developed countries. Sri Lanka, Nepal, and Indonesia were the countries with the lowest DMFT those aged 12. Even though DMFT percentages were lower for 12 year olds the CPI (Community Periodontal Index) scores, which explain the periodontal health, were very high for 35-44 and 65-74 year olds. This suggests that DMFT percentages for 12 year olds in Sri Lanka and Nepal were lower not because of better access to oral health services, or the success of prevention strategies, but possibly because of the sugarless diet in those countries. Table 5 and Table 6 show that even though the incidence is very low in South East Asian countries compared to other developed countries, because of the lack of oral health services, the percentage of untreated decay is surprisingly high. This would appear to be because of the low dentist to patient ratio and lack of school dental services and other community based intervention in those countries (World Health Organization, 2008).

Table 5 shows that the percentage of untreated decay at age 12 was very high for most countries, with India having the highest percentage of 94.4% which is explained by the lowest dentist to patient ratio compared to other countries on the list. The number of children without dental caries at 6 years (almost 50%) was high compared to other countries. In contrast, 6 year-olds in Australia showed a higher caries prevalence compared to 12 year-olds between 1987 and early 2007 (Mejia & Ha, 2011) because Australia is a country with a very low DMFT index compared to other developed countries. This trend was investigated in a study controlling for the structure of primary dentition, availability of fluoride varnish to 12 year olds, and the difficulty in establishing oral hygiene practices as predictor variables. The ease of convenience of school dental services to 12 year olds was indicated as the reason behind more DMFT in 6 year olds (Mejia & Ha, 2011). A trend of more decay in 12 year olds in India compared to 6 year olds might be due to lack of school dental services in India.

Community Periodontal Index (CPI) scores in the other age groups were also less than the other countries which indicate that in the total Indian population, the age groups; 6 year olds, 35-44 and 65-74 were least affected. The DMFT data for 12 year old Indian adolescents were considerably higher than other countries which suggest that the adolescent population is at risk. The reasons behind this result require further investigation but the knowledge that the adolescent age group is an “at risk” population is significant for the current study because the selected study population for this thesis is 12-15 year-olds and the current study will help inform the knowledge gap.

Table 5:Treatment needs in 12 year olds: South East Asia (World Health Organization, 2009) (Source: © World Health Organisation See appendix C)

Country	Caries free at age 6 (%)	DMFT at age 12 %	Untreated decay at age 12	CPI score 3		CPI score 4		Edentulousness (%)		Mean no. of missing teeth
				35-44 yrs	65-74 yrs	35-44 yrs	65-74 yrs	35-44 yrs	65-74 yrs	35-44 yrs
Bangladesh	NR	2.2	NR	NR	NR	NR	NR	NR	NR	NR
India*	48.1	1.8	94.4	11.6	21.4	7.8	18.1	0.5	17.6	2.9
Indonesia	14	0.9	29.8	NR	NR	NR	NR	0.4	23.6	NR
Maldives	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Myanmar	NR	NR	NR	2.4	NR	1.6	NR	NR	NR	NR
Nepal	42.5	0.5	25.6	43.8	34.3	21.6	42.8	NR	NR	0.8
Sri Lanka	37.7	0.9	85.7	14.6	16.0	2.3	3.8	0.1	21.8	5.7
Thailand	19.4**	1.6	54.2	22.1	15.5	15.4	68.8	NR	10.5	3.9
Timor- Leste	28	1.8	66.3	22.5	28.4	6.2	14.4	0.6	25	0.4

CPI - Community Periodontal Index; CPI score 3 - pockets 4-5 mm; CPI score 4 - pockets 6 mm or more; DMFT - Decayed, Missing and Filled Teeth; NR - not reported (data not available)

Source: information provided by the national focal points attending the consultation;

* - for India: R K Bali, V B Mathur, P P Talwar, B Channa. National Oral Health Survey and Fluoride mapping 2002-2003. Dental Council of India, 2004

** - for Thailand: caries free at age 5

Table 6: Dentists to Population Ration in South East Asia (World Health Organization, 2009) (Source: © World Health Organisation See appendix C)

Country	No. of dentists	Dentist/ population ratio	% working in			
			Public service	Private practice	Dental schools	Other sectors
Bangladesh	3,000	1 : 51,182	21	64	11	4
Bhutan	7	1 : 112,000	100	0	0	0
India*	78,096	1:30,000	3.8	NR	14.3	NR
Indonesia	17,856	1 : 12,257	21	NR	11	NR
Maldives	30	1 : 10,000	50	50	0	0
Myanmar	1,648	1 : 34,000	33	57	10	0
Nepal	705	1:37,485	6	90	10	4
Sri Lanka	1,700	1 : 11,764	62	41**	4	4
Thailand		1 : 6,734	33.9	53.4	9.2	3.5
Timor Leste	6	1 : 166,667	100	50**	0	0

Source: information provided by the national focal points attending the consultation;
* - for India: Central Bureau of Health Intelligence, India (http://www.cbhidghs.nic.in/)
** - part-time; NR - not reported (data not available)

In comparison to India the other countries in South East Asia are much smaller nations with smaller populations. It will therefore be much easier for the WHO to provide material and technical assistance to implement national oral health programmes in these other smaller countries. The main barrier for India is the density of the population and this itself suggests that the country needs a single national oral health policy that can be integrated with the state health policies. The national health policy should avoid inequalities between states and Union Territories. Currently, the accumulation of dental surgeons in the urban areas leaves the rural population largely lacking even basic oral healthcare services such as pain management (World Health Organization, 2009). Government policies should be concentrated more on filling this huge gap between rural and urban settings. Currently, the number of dentists working in the public services sector in India is only 3.8% of all dentists in India (World Health Organization, 2009), (see Table 6), which is very low compared to other countries in South East Asia. Thus the barriers to improving oral health services in India are: geographic variation, lower dentist to population ratios, and a low priority given to oral health. Currently, less priority is given to public oral healthcare and therefore more sophisticated strategic plans are required to break these barriers. This can be achieved by understanding the current oral health status and treatment needs of the rural and urban population in different states of India. There are various studies conducted in different states of India including a 2002 National Oral Health survey (Bali et al., 2004). Each relevant published study conducted in India is discussed in the next section.

2.3.3 Dental Caries in India

Dental caries were highly prevalent in developed countries and have been brought under control during the last three decades (Chen & Hunter, 1996; da Silveira Moreira, 2012b; Fulton, 1951; Marthaler, 2004; Medeiros et al., 2001; Mejia & Ha, 2011; Robb & Seddon, 2006; Selwitz et al., 2004). This was achieved mainly through community or school based organised primary preventive programmes. At present, India is also passing through the same phase as developed countries did in the 1970s regarding the prevalence of dental caries (Shah et al., 2007). A number of epidemiological surveys carried out in India indicate that caries are still fairly prevalent and are a major public health problem. In a study conducted in 1977, Tewari and Chawla indicated that 72% of 6-16 year olds were affected by dental decay with an average DMFT rate of 3.93 and these results were confirmed in various studies conducted in different parts of the country at that time (Mathur & Jain, 1979). Mathur and Jain identified that the scarcity of dentists to the population, as well as the low priority given to oral health issues by policy makers, as the key priority areas to be improved. They also stressed that prevention measures at the individual level were the only option at that time. The priorities remain unaltered and 35 years after Mathur and Jain's work, the current thesis has almost the same objective: the prevention of dental caries by oral health literacy at the individual and community level. The literature indicates that there has been no progress in DMFT rate, prevalence percentage, oral health policies, and prevention strategies in India for the past three decades in spite of tremendous growth in the Indian economy and other sectors. Some of the relevant studies are reviewed and presented here.

2.3.3.1 History of severity and caries prevalence in India

Trends in dental caries prevalence in those aged above 12 years between the year 1960 and 1987 in different parts of the Indian states are shown in Table 7 and Table 8 (A. Tewari, 1991). The results presented in Table 7 and Table 8 was from studies undertaken by individual researchers from different parts of India and sample sizes were very low except for two studies. The average prevalence percentage was between 40% and 62%. The DMFT rate was between 0.5 and 2.5, except for few studies where DMFTs were slightly higher, but none of the studies reported a DMFT score more than 4 (A. Tewari, 1991). Since Tewari's report in the early 1990s trends in DMFT have changed and therefore only studies published after 2000 were selected for review so that more recent trends could be understood.

Table 7: Prevalence and Severity of Dental Caries in 1984 in India (A. Tewari, 1991)

Age Group	% affected	DMFT	D	M	F	Year
12 years	70.0	2.1	-	-	-	1984
15-19 years	87.0	4.9	-	-	-	1984
30-34 years	62.0	3.5	-	-	-	1984
35-44 years	61.0	2.2	-	-	-	1984

Key: - data not available

Table 8: Prevalence and Severity of Dental caries in Different States of India between 1967 and 1983 (A. Tewari, 1991)

Age Group	State	% affected		DMFT	
		Urban	Rural	Urban	Rural
12 years	Orissa	64.0	63.0	2.1	2.1
15 years	Chandigarh	51.0	63.0	1.4	2.2
	Haryana	50.0	48.0	1.4	1.3
	Himachal	50.0	49.0	1.2	1.3
	Lucknow	43.0	21.0	1.0	0.5
	Jammu & Kashmir	-	-	1.5	4.4
	Orissa	62.0	63.0	2.0	2.1
	Bihar	43.0	50.0	1.1	1.3
	Bombay	96.0	-	4.7	-
	Indore	68.0	-	2.8	-
	Kerala	42.0	46.0	1.0	0.9
	Andhra Pradesh	50.0	34.0	1.2	2.0
	Karnataka	67.0	43.0	2.0	1.1
	Meghalaya	60.0	-	2.0	-
	Manipur	64.0	-	1.8	-
	Assam	84.0	-	3.1	-
	Nagaland	63.0	-	2.4	-

Key: - data not available

2.3.3.2 Recent Trends in prevalence and severity of dental caries in India

The literature was reviewed to understand the prevalence of the dental caries percentage and DMFT value of five parts of India namely: North, South, West, East and Central India. The studies conducted in union territories are discussed separately. In the main, the WHO oral health survey methods were used and the findings were presented based on the DMFT average in the studies reviewed except for one study in Goa which has used Moler's Index. In the current thesis, WHO oral health survey method was used to collect data and DMFT values were used to analyse and report the findings.

2.3.3.2.1 National Oral Health Survey and Multi-centric study

There were two major studies conducted in India which included more than one state of India. The first national level epidemiological survey was conducted by the Dental Council of India in 2002-2003. The second study was conducted by government of India and World Health Organisation (Shah et al., 2007).

The aim of the National Oral Health Survey (2002) was to collect baseline information for various dimensions of oral health, including the prevalence of dental caries, oral health diseases, and fluorosis. The survey was conducted in every states of India and each state was divided into a number of homogenous regions comprising of districts on the basis of agro-climatic factors used by the planning commission. A three stage sampling procedure was adopted to select number of participants from rural (n=210) and urban areas (110) in the following age groups: 5 years, 12 years, 15 years, 35-44 years and 65-74 years.

The results of this survey were used in the South East Asian study to compare with other South East Asian countries (see Table 5). The prevalence of dental caries reported at 12 years and 15 years of age were 52.5% and 61.4% respectively. The prevalence reported for Tamil Nadu 12 year olds was 52.5% and for 15 year olds it was 60.0%. The DMFT average reported for 12 year olds was 2.5 and it was 3.4 for 15 year olds. The results indicated that DMFT average increased with age.

The National Oral Health Survey included Thanjavur district in Tamil Nadu but the authors noted that the sample from Thanjavur region was dominated by an urban population; hence the results for the prevalence of dental caries in the sampled age groups for rural areas would be under-represented. The prevalence reported for 12 year olds in Thanjavur was 51.4% and it was 60.7% in 15 year olds but the mean DMFT values were not reported. Recent studies conducted in Tamil Nadu have reported a higher prevalence and DMFT compared to the Nation Oral Health Survey. Those studies are discussed in the next section.

The recent multi-centric nationwide study conducted by the WHO and the Indian Government included seven sites in India (see Table 9) (Shah et al., 2007). The states were Arunachal Pradesh, Maharashtra, Rajasthan, Orissa and Utter Pradesh and two Union Territories (Delhi and Puducherry). The average DMFT scores and percentage of caries prevalence for different age groups at the seven different sites are presented in Table 8. For 12 year-olds, the lowest prevalence of dental caries was found in the eastern state of Orissa (DMFT=2.3) with a prevalence of 23%, and Puducherry had the highest score (DMFT=3.8) with a prevalence of 71.5%. In 15 year olds, an exceptionally high prevalence of dental caries (DMFT=4.9) was recorded in the Union Territory of the Puducherry province and the lowest at Orissa (DMFT=2.7). For all other states the DMFT was below 3.1 (Shah et al., 2007). This result is very important for the current research because Puducherry is a union territory geographically located within Tamil Nadu. Puducherry and Tamil Nadu share the same culture and language but not the same government.

Puducherry is a former French colony, consisting of four non-contiguous enclaves, or districts. Puducherry was under French rule until 1954 even after India was granted independence from Britain, in 1947. According to the Treaty of Cession of 1956, the four former French colonies in India were assured of maintaining their special administrative status. This is important because Puducherry is a comparatively more sophisticated area compared to Tamil Nadu and Puducherry has organised health and education systems. The Arovillie Dental Centre is located in Puducherry and was developed by a French dentist in 1994. It continues to give free dental service to the people in that area. The services include: preventive care in schools; training for village women as health community workers; education in oral health for teachers; children and parents; and basic treatment in 13 sub-centres.

The Nationwide WHO survey was conducted ten years after Arovillie had been established, but the results of the survey were shockingly poor compared to other parts of the country (Shah et al., 2007). One reason could be the highly westernised diet because of French influence in this area. The Union territory of Puducherry is completely surrounded by Tamil Nadu and shares the culture and language with Tamil Nadu but under the different administration and Government. The prevalence of dental caries in Tamil Nadu is discussed later in this section referring to the recent literature.

Table 9: Prevalence and Severity of Dental Caries between 2001 and 2014

Year	Author	State	Sample (frequency)	Age (years)	Prevalence of dental caries				DMFT index score			
					Urban	Rural	Boys	Girls	Urban	Rural	boys	girls
Eastern States of India												
2001	Mandal et al.,	West Bengal Orissa	237 241	15-16 15-16	21.0 18.3	15.2 19.8	-	-	0.35 0.29	0.30 0.32	-	-
2007	Shah et al.,	Arunachal Pradesh	1166	15	51.3	45.9	43.2	53.9	1.61	1.33	2.18	1.76
2007		Orissa	473	15	23.1	25.6	23.2	25.4	0.54	0.65	0.57	0.62
2013	Dulal et al.,	West Bengal	724	12-14	42.40		45.56	39.29			2.12	2.36
Western States of India												
2012	Shingare et al.,	Maharashtra	472	3-14	73%				2.66			
2014	Ajithkumar et al.,	Gujarat	1539	12	18.5%				-			
Northern states of India												
2009	Dhar et al.,	Rajasthan	827	11-14	51.48				1.84			
Southern states of India												
2011	Babu et al.,	Andra Pradesh	1590	7-9	71				0.71-1.95			
2011	Babu et al.,			10-12	55.7							
2013	Suprabha et al.,	Karnataka	590	11-13	59.4				-			

Table 10: Results of Multi-centre Study of dental caries and DMFT scores in India (Shah et al., 2007)

Age groups	State	% affected	DMFT
12 years	Arunachal Pradesh	44.4	1.0
	Delhi	48.6	1.1
	Maharashtra	50.4	1.3
	Puducherry	71.5	2.7
	Rajasthan	53.8	1.4
	Orissa	23.0	0.5
	Uttar Pradesh	49.8	1.3
15 years	Arunachal Pradesh	48.5	1.45
	Delhi	52.4	1.45
	Maharashtra	58.5	1.7
	Puducherry	83.4	4.05
	Rajasthan	55.4	1.7
	Orissa	24.3	0.6
	Uttar Pradesh	54.9	1.7
35-44 years	Arunachal Pradesh	62.1	2.6
	Delhi	86.2	4.6
	Maharashtra	86.4	5.3
	Puducherry	73.3	3.8
	Rajasthan	66.5	2.5
	Orissa	48.1	1.7
	Uttar Pradesh	83.2	4.2
65-74 years	Arunachal Pradesh	80.7	6.0
	Delhi	55.2	4.4
	Maharashtra	83.0	6.5
	Puducherry	55.6	5.3
	Rajasthan	54.0	2.4
	Orissa	51.6	2.9
	Uttar Pradesh	95.1	15.5

Table 10 also indicates that the DMFT and prevalence of dental caries are increasing gradually between the age 12 years and the age group 65-74 years which indicates that decayed teeth were not treated because of the nature of the oral health services and a lack of awareness of how to treat the disease. Also the missing teeth component of the DMFT index might be expected to be higher in the 65-74 year old group compared to the 12 year old group, because as they grow older their oral health is likely to become increasingly compromised because of other common chronic long-term health conditions such as diabetes (Miko et al., 2010). National policies should concentrate more on treating diseases and improving awareness among the population regarding the natural disease progression of dental caries from one tooth to another.

Limitations: The selection of seven sites (states) for the study was based on the availability of material and human resources to conduct the study and this is a limiting factor. Within that, however, the districts, villages and schools for the study were randomly selected, and this is a mitigating strength. To reiterate other states were not included in this study because they had a lack of resources required to conduct the survey (Shah et al., 2007) which suggests that the availability of oral health services was potentially even lower in those regions. This, therefore, is the major limitation of the Shah et al., multi-centric study. If states and Union Territories were randomly selected, the study results would have been generalisable and the external validity of the study greatly improved. The above limitation also applies to the current thesis: this was unavoidable because of the scarcity of resources for this doctoral project. Because of this the sample selected was a convenience sample. In the coming sections, studies conducted in other parts of India for the adolescent age group are discussed.

2.3.3.2.2 Studies in Eastern states of India

A study by (Mandal, Tewari, Chawla, & Gauba, 2001) was conducted in three eastern states of India (Orissa, West Bengal and Sikkim) with a total sample of 2,067 involving three age groups, 5-6, 15-16, and 30-35 year olds. The prevalence reported for 15-16 year olds, shows a higher prevalence rate in urban areas for West Bengal and Sikkim and slightly lower for Orissa (see Table 9). The decayed (d/D) component contributed more to the total deft (d-decayed tooth, e-decayed tooth indicated for extraction, f- filled tooth in deciduous) DMFT (permanent) and defs/DMFS (Decayed, Missing, and Filled Surfaces) score. The “missing” component contributed more than “filled” teeth which was negligible or absent. This result explains a lack of oral health services and awareness in these communities.

Limitation: The major limitation of study by Mandal et al., (2001) was sample selection and sample size calculation which could have biased the result. This is, because the authors did not report the sample selection in sufficient detail and therefore it is not known if the sample selection were a convenience sample with only healthy or higher socioeconomic people participating. The DMFT score ranged between 0.35 and 0.54 for 15-16 years in both urban and rural areas which was unusually low compared to other studies which reported DMFT scores between 2.0 and 2.5 (See Table 10). Mandal et al. (2001) indicated that the healthy diet for this age group produced the unusual result but not enough explanation was given for the reasons behind the healthy diet consumed by 15-16 year olds in these states. The authors indicated that samples were selected from schools, but because the type of schools were not reported it is hard to gauge the socioeconomic status of the participants.

The study has reported only the mean DMFT/dmft (Decayed, Missing and filled deciduous teeth) and prevalence of dental caries and other basic information such as DMFT difference within gender and other sociodemographic variables were not reported. One reason for this might be that there were too few participants within each age group to enable such reporting.

For example, in each state there were approximately 240 participants in the 15-16 years old group from both urban and rural areas. Mandal et al. (2001) stated that approximately 100-150 individuals in each age group were examined based on the WHO criteria set by WHO, which indicates that when the level of procession of ±1 is anticipated, each subgroup within a selected sample should contain at least 100 participants with the 95% confidence interval included in the presentation of results. This criterion is appropriate only for understanding the mean DMFT for each subgroup but it is a disadvantage for more complex bivariate and multivariable analysis to understand predictors of DMFT such as gender and other socioeconomic indicators. A large study like this, which was aimed at comparing caries status of three different states, is uncommon in India because of the required level of funding and resources. It would therefore have been more useful if the sample size were big enough to perform further analysis to understand the predictors of DMFT and prevalence for each individual state. In the current thesis, there were 450-550 participants in each subgroup and the sample size selection procedure is described in the next chapter.

A study by Dulal Das, Misra, Mitra, Bhattacharya, and Bagchi (2013) was conducted in two coastal districts of West Bengal with a sample of 1,764 children of three age groups 6-8 years, 9-11 years and 12-14 years. In the total sample, 724 children were 12-14 years of age and reported 42.40 % of caries prevalence with mean DMFT of 2.12 and 2.36 in girls and boys, respectively. An increase in caries prevalence is noticed between these two studies conducted in 2001 (Mandal et al., 2001) and 2013 (Dulal Das et al., 2013) in West Bengal.

Limitation: Dulal Das et al. (2013) study was very well designed and the sample size was sufficient to perform contingency analyses and cross tabulations. The authors indicated that caries' prevalence changed with geographical location and they reported this as a main reason for recruiting participants from two districts. There was not, however, a full description of where the schools were located and therefore it is not easy to understand the rural-urban differences in prevalence of dental caries. There is a significant difference between rural and urban areas with respect to access to oral health services, economic status, and diet. It is for this reason that for the current thesis participants were selected from both rural and urban areas of Tamil Nadu and differences between prevalence and severity of dental caries were assessed by controlling for other sociodemographic factors that were analysed and reported.

Another limitation in the Dulal Das et al. (2013) study was the participants were recruited only from public schools. The socioeconomic status of public and private schools differ in India because of the nature of the fees structure in private schools. Dulal Das et al. recruited participants mostly from lower socioeconomic back grounds and therefore their reported dental caries percentage and DMFT scores are likely to be higher than might be expected had the participants been attending private schools, and as a consequence the true population values for these age groups are likely to be lower than reported in this study.

Pratiti and Pratyay Pratim (2013) conducted a prevalence study in a small population in Sundarban, West Bengal, India. The overall prevalence of dental caries was reported as 72% and although there was a higher prevalence in female participants (76%) compared to male participants (68.8%), this is not statistically significant ($X=0.73$; $p>0.5$). The study population was 12 -15 year olds which matches the current thesis study population. In this study, data on the participants' religion was reported and the prevalence for Muslims (73.7%) was slightly higher than Hindus (71.3%) but similarly this difference is not statistically significant ($X=0.09, p>0.05$) (Pratiti & Pratyay Pratim, 2013). In the current thesis, caste was selected because Government funding and subsidies are decided based on the caste system rather than religion. Furthermore, individuals can decide their own religion and convert from one to another religion during their lifetime but for the caste system a person cannot change this because it is determined only by birth and remains unchanged throughout a person's life.

Another important result reported in this study was the socioeconomic status of adolescents based on their household income with INR 1,800 reported as the median household income. The results indicated that students grouped into income per capita above INR 1,800 had less decay prevalence (59.7%) compared to those below INR 1,800 (84.2%). Further detail on how income information was collected from the adolescent participants was not reported. In the current thesis, income details were not collected because it was anticipated that collecting house hold income from adolescent participants would be inappropriate. A different method was used to understand the socioeconomic status of participants and this is explained in the chapter on methods.

2.3.3.2.3 Studies in Western States of India

Shingare et al. (2012) conducted a study in Raigad district, Maharashtra to determine the prevalence in the age group 3-14 years with a total sample of 472 participants. In this sample, 163 participants were in the age group 11- 14 and the prevalence of dental caries was reported to be 73% and DMFT score was 2.66. This study was conducted in a rural population, the schools were randomly selected but the type of school (public or private) was not reported (Shingare, VJogani, Serekar, Patil, & Jha, 2012).

Limitation: The results were not reported separately for female and male participants but this could be because of the small sample size. The description for the sample selection, methods selection, and methodology were not well reported, and this is another study limitation.

Ajithkrishnan et al. (2014) conducted a dental caries prevalence study in Gujarat, a western state of India. A total of 1,539 12 year-old school children attending both private and public schools were selected using a stratified random sampling procedure in which private and public schools are stratification variable. The prevalence of dental caries was reported as 13.84% in private school and 23.78% in public school children. The prevalence percentage is unusually low compared to other studies as well as the current thesis results. The author did not give any explanation for the noticeably lower caries prevalence in this study (Ajithkrishnan, Malvania, Thanveer, & Hongal, 2014). The reason behind this unusual result would be the lower proportion of SC (Dalit) population in this state. In Gujarat, the proportion of Dalit population is lower (6.7%) when compared to other states of India (around 20%). Hence, proportion of Dalit population in this study would be less and therefore the higher class population would have been represented to a greater extent in the study and this decreased the prevalence percentage to an unusual extent.

In the current thesis, participants from the Scheduled Caste and Scheduled Tribes had a higher prevalence of dental caries compared to other higher class participants with these results being statistically significant. These results will be described further in the results chapter.

In this study, a standard sampling procedure was followed which includes a lottery method for participant selection, within each selected school. In the current thesis, a random sampling procedure was followed for the selection of schools, and one class room was randomly selected within each school, rather than the lottery method of participant selection followed in Ajithkumar et al.’s (2014) study. In the current thesis, the lottery method was rejected as a limitation during the proposal stage. It was anticipated that the majority of adolescents would not have had a dental examination in the rural parts of Tamil Nadu and examining every student in the selected class was considered a fair, ethical, and equitable practice. In the current study, 91% of participants reported that they had never been to dentist nor had any oral health examination previously: the results supported this decision.

2.3.3.2.4 Studies in Northern States of India

In Rajasthan, 1,587 school children in the age group 5-14 years were examined for dental caries and in just over half of the sample 812 participants were aged 11-14 years. The results indicated that the DMFT index was 1.84 with a prevalence rate for dental caries of 51.48% (Dhar, Jain, Van Dyke, & Kohli, 2007). In the 2004 WHO survey, it was slightly lower (DMFT=1.71) among 15 year-olds. The dental caries prevalence in 6-10 year olds was reported as 63.02% in 6-10 year-olds in rural areas of Rajasthan in another study conducted in 750 school children (Dhar & Bhatnagar, 2009).

Limitation: The data collection for this study was undertaken over almost one year and the study reported the prevalence of dental caries, however, for this kind of study reporting, the incidence of dental caries would have been more appropriate. This is because incidence of disease indicates the number of individuals in a population who experience new disease during a specific time period whereas prevalence measures the number of individuals with dental caries in a population at a specific point in time.

A study conducted in urban areas of the Punjab region had the main aim as determining the timing of permanent teeth emergence and identifying the incidence of dental caries in 1,648 school children aged 5-16 years recruited in urban schools. In this study, participants were recruited from both private and public schools (Table 9). Because this study was conducted for more than a year, incidence of dental caries was reported rather than the prevalence. The incidence of dental caries indicated a high decay percentage in public school participants (8%) compared to private school participants (6%). In this study, only the Sikh religion of Punjabi origin was included in the survey. The reason for this population selection was not indicated and this is a major limitation of the study.

In Nainital district, Uttar Pradesh, a total of 722 school children in the age range 7-12 years were examined (Grewal et al., 2009). Dental caries prevalence was calculated separately for 7-9 year olds and 10-12 year olds with the DMFT/deft of 1.97 and 2.61 respectively. The study was conducted in rural areas where prior data were not available. The overall dental caries prevalence rate was 77.7% and Grewal et al., (2009) indicated that almost 80% of children needed dental intervention of which 60% of them required filling. A low dentist to population ratio (1:197,199) indicates that children in this area were at a greater risk of acquiring oral disease. The geographic location of this state is in the hills of the Himalayan Mountains where oral health awareness and oral health facilities are almost negligible. An ethno-medical survey, a study conducted to understand the tribal knowledge of plants, was conducted in this area. It indicated that 17 medicinal plants were used for different oral health issues and most of the village people are still using Ayurveda (medicinal plants) for treating dental caries and have never been to a dentist (Bhardwaj & Bhardwaj, 2012). The effect of Ayurveda treatment on preventing dental caries is not well documented in the literature. The prevalence rate in this state is higher compared to other parts of India which suggests that Ayurveda might not be an effective treatment for treating dental caries. In addition it may be that the diet is a contributing factor to their poor oral health status. Improving oral health awareness among people in rural parts of this state would educate them to choose between Ayurveda and more effective dental treatments.

2.3.3.2.5 Studies in Southern states of India

A study in Nellore, Andra Pradesh, (Babu, Nirmala, & Sivakumar, 2011) was carried out in 7-12 year olds with a sample size of 1,590. The study was conducted in 20 schools in both urban and rural areas. The dental caries prevalence was reported as 71% and 55.7% for 7-9 year olds and 10-12 year olds respectively with overall caries prevalence as 65.6%. The average DMFT was between 0.71 and 1.95. The higher dental caries prevalence rate in female participants was reported even though they also had comparatively better oral hygiene than male participants. The reasons might be the early eruption of teeth in females and also the nature of tooth anatomy which differs between males and females. The diet might be another major contributing factor for this difference in prevalence percentage because females have less access to nutritional food when compared to males in India (Dilip Das & Biswas, 2005). The procedures involved in the selection of schools, class rooms, and participants were not reported in the study.

A study was conducted in the Mangalore district in Karnataka among 11-13 year olds to identify the prevalence of dental caries and knowledge, attitude, and practices (Suprabha, Rao, Shenoy, & Khanal, 2013). The study reported that 59.4% of participants had dental caries and 54.5% of the participants had low oral health knowledge. The children with low knowledge had a significantly higher odds of having DMFT ≥1, not using fluoridated tooth paste, and of being afraid of going to the dentist (Suprabha et al., 2013).

2.3.3.2.6 Studies in Union Territories of India

“A Union Territory is a type of administrative division in the Republic of India. Unlike States, which have their own elected governments, Union Territories are ruled directly by the Union Government (Central Government), hence the name Union Territory” ("Union Territory," n.d). The dental surveys were conducted separately for these areas. The major Union Territories such as Delhi and Puducherry were included in a nationwide multi-centric study in 2007. Other than those above, relevant data were available only for Goa and Chandigarh. The dental caries prevalence in these four areas (see Table 11) is discussed below.

A study by Mascarenhas (1999) was conducted in 12-13 year old school children in Goa. The data were collected from 1,189 school children and reported that almost 78% of participants were affected by dental caries. The DMFT and DMFS were 2.78 and 4.20 respectively. The prevalence of dental caries in 15 year olds in Delhi and Puducherry (See Table 5) is 83.4% and 52.4% respectively (Shah et al., 2007). A study by Goyal, Gauba, Chawla, Kaur, and Kapur (2007) reported the dental caries prevalence in Chandigarh in 2007. This study was conducted in four age groups with total sample of 1,816 school children aged between 5 -15 years. The dental caries prevalence in 15 year olds was reported as 87% with mean DMFT 3.82. The author reported that lack of oral health awareness as the reason to explain the study results (Goyal et al., 2007).

Chandigarh has a high literacy rate and favourable dentist to population ratio and in spite of all these positive influences on oral health, the dental caries prevalence was markedly increased in this area compared to other areas of India.

Table 11: Prevalence of Dental caries in Union Territories of India

Union Territories	Year of study	Dental Caries Prevalence %	DMFT 15 years
Goa	1999	78%	2.78
Delhi	2007	52.4%	1.45
Puducherry	2007	83.2%	4.08
Chandigarh	2007	87%	3.82

To sum up, the prevalence rates of dental caries in Indian states and Union Territories is increasing. Most of the studies indicated that the “decayed” component contributes more to the total DMFT values, which indicates that children are not getting good oral health treatment. There are various reasons reported in the literature to explain this, such as, a lack of oral health awareness and low dentist to population ratios. Most of the studies used the

WHO index (Bali et al., 2004; Dulal Das et al., 2013; Grewal et al., 2009; Mandal et al., 2001; Mascarenhas, 1999; Mathur & Jain, 1979; Shah et al., 2007; World Health Organization, 2008) for measuring dental caries prevalence except one study which used Moller's index (Goyal et al., 2007).

In both rural and urban areas there is an increasing trend in prevalence of dental caries in the past few decades. Dental caries prevalence is also increasing in preschool children in recent years. The population selection criteria and power calculations were not indicated in any of the studies discussed except the multi-centric survey (Shah et al., 2007). Oral health inequality was reported in a study by Kakde, Bedi, and Verma (2013), in which 1,764 dentists were asked the socioeconomic status of their patients and only 7% indicated that they were in the lower socioeconomic group. In another study, only one religion was selected for the study and a proper explanation for selection criteria was not reported.

2.3.4 Dental Caries in Tamil Nadu

The current study was conducted in two selected districts of Tamil Nadu and therefore, the studies published for this state are discussed in this section (see Table 12).

A total number of 1,200 school children in the age group of 5-12 years in Chennai city were studied in 2005 (Mahesh, Joseph, Varma, & Jayanthi, 2005). The study was conducted on school children from 15 public (n=600) and 15 private (n=600) schools. In each school, 40 children were examined: 5 year olds (n=20) and 12 year olds (n=20). Among the 5 year olds, the DMFT index was 3.5 and for the 12 year olds it was 3.80. This study also indicated that there was no statistical difference in the prevalence of dental caries between private and public schools. The result indicated that 16.5% of teeth examined needed treatment in participants from public schools and about 15% of examined teeth required treatment in participants from private schools. This indicated that oral health awareness to identify decay and seek dental treatment was low among all socioeconomic groups. The study also indicated that irrespective of socioeconomic status oral hygiene was good among all students and dental caries was slightly higher for public school students. This result indicates that the intensity of dental caries is determined not only by oral hygiene but also by other factors, such as access to nutritional food, which is compromised in public school children from low socioeconomic backgrounds. Compared to their male counterparts (DMFT=3.80), 12 year old females had slightly higher decay (DMFT=4.11) but 5 year old females had less decay than male children. This might be in part because of hormonal changes during puberty and limited access to nutritional food for female children for various cultural reasons (Dilip Das & Biswas, 2005).

In Mahesh et al.'s (2005) study the parents' income was recorded with the help of school management. In the current thesis, attempts to collect income status from school management was undertaken but because the researcher was from a non-Indian university, more than half of the schools participating in the research did not agree to provide the income information requested. For this reason, in this thesis, only the type of schools and location of schools (private, public, rural and urban) were used to describe the socioeconomic status of participants. Mahesh et al.'s (2005) Chennai study indicates that children from public schools were generally from low income groups (98.3%) and every child studied from a private school was from a higher socioeconomic group (100%). This result demonstrates that using the type of school as indicator of socioeconomic status in Tamil Nadu would not bias the result in the current study.

A recent study compared the dental caries prevalence among 12 year old school children in urban and rural areas of Tamil Nadu (Prabhu & John, 2013). The study was conducted in the Chennai district and Kanchipuram district which is geographically located close to Chennai. In this study, the Mann-Whitney U test was used to compare the DMFT means. The mean

DMFT for the total sample was 1.52 and among urban children the mean DMFT was 1.61 whereas in rural children DMFT is slightly lower (1.43). The methods of recruitment of participants were not clearly stated in this study. It was mentioned that children were recruited from the Porur suburb of Chennai city but further details about where they were recruited from, such as schools or dental clinics, and clear details about their socioeconomic status were not indicated. Prabhu and John (2013) also found that female children had more decay compared to males, which aligns with the earlier study by Mahesh et al., discussed above. The number of filled teeth was slightly higher in the urban area than in the rural area which was an expected result in this study because of greater access to dental services in Chennai city. The urban children were recruited from Chennai and the DMFT index was markedly reduced in Prabhu and John’s (2013) study when compared to the (Mahesh et al., 2005), (DMFT=3.80) as discussed above.

A study was conducted in the rural part of Kanyakumari district among 150 children aged 6-12 years with an equal number of boys and girls (Sunitha, Joshi, & Rajesh, 2005). In the total sample, 77% of children were affected by dental caries. The DMFT index in boys (DMFT=1.25) was slightly higher than in girls (DMFT=0.96). A possible reason for very low mean DMFT in this rural part of Kanyakumari district could be geographic because there is both a dental college and a hospital nearby, which for more than the last ten years has provided free dental treatment for children aged under 12 years. For this reason, in the current study, even though the schools were randomly selected the geographic location of schools was noted and has been considered in the discussion of the results.

Table 12: Prevalence and Severity of Dental Caries in Tamil Nadu

District	Year	n	DMFT	Prevalence	Age	Author
Chennai (urban)	2013	352	1.52	67.3%	12	Prabhu et al.,
Chennai (urban)	2005	1200	3.80	80%	12	Mahesh et al.,
Kanchipuram (rural)	2013	348	1.61	65.8%	12	Prabhu et al.,
Kanyakumari (rural)	2005	150	1.2	77%	12	Sunitha et al.,
Chidambaram (rural)	2008	508	2.57	90%	9-10	Saravanan et al.,
Chidambaram	2002	1054	2.56	65%	12-15	Moses et al.,

Saravanan et al., (2008) conducted a study in rural parts of Chidambaram district of Tamil Nadu in 2008. The sample size was 508 children from the age group 5-10 years. The mean DMFT score was 3.54 in the 5-6 year olds and 2.57 in the 9-10 year olds. In this study, the prevalence of dental caries was 90% which was higher than in all of the studies discussed above. It would seem, therefore, that the prevalence of dental caries demonstrates an increasing trend in the rural and urban areas of Tamil Nadu (Saravanan et al., 2008). Another study (Moses, Rangeeth, & Gurunathan, 2011) was conducted between 2002 and 2003 in three age groups (5-8, 9-11 and 12-15 years). In that study, 1,054 children were in the age group 12-15 years and 65% of them reported being affected by dental caries (mean DMFT between 2.56 and 3.07). The girls were less affected than boys.

The current study was designed in such a way as to compare rural and urban areas involving a bigger population. The Tamil Nadu Government is in the process of increasing primary oral health centres and the proposed study results will be used to decide the strategies and design of the intervention programmes for different districts in Tamil Nadu.

2.4.1 Measuring Oral Health Literacy

Fifteen studies (see Table 13) identified in the literature were conducted to develop a validated instrument to measure oral health literacy in adults both in hospital and research settings. Two of these studies were excluded because they only dealt with a word recognition instrument for Spanish speakers.

Even though those 15 studies were intended to develop a validated oral health literacy questionnaire, a number of other factors became evident from the research, such as the impact of low oral health literacy on self-perceived oral health status (Richman, Huebner, Leggott, Mouradian, & Mancl, 2011), health beliefs and attitudes (Atchison, Gironda, Messadi, & Martirosian, 2010), oral health status (M. Jones et al., 2007; Macek et al., 2010), dental outcomes (Gong et al., 2007); not visiting the dentist (M. Jones et al., 2007); and dental anxiety (Shin, Braun, & Inglehart, 2014). In contrast to the current study the above studies were undertaken with adult populations and also the definitions and meaning for oral health literacy differed slightly from the one adopted for the current research.

Table 13: Measuring Oral Health Literacy

Author and year Country	Primary objective	Participants	Definition adopted	Instrument used	Key results
Baur et al. (2005) USA	Defining oral health literacy	-	Oral health literacy is the "degree to which individuals have the capacity to obtain, process and understand basic oral health information and services needed to make appropriate health decisions"	-	-
Lee et al. (2007) USA	Developing a word recognition instrument for measuring oral health literacy in adults population	Adults (n=202)	As above	REALD 30	Developed instrument had good reliability but only partial validity
Jones et al. (2007) USA	To examine the association of knowledge, oral health status and oral health literacy.	Adults (n=101)	As above	-REALD 30 -Dental knowledge questionnaire with two items -Self-perceived oral health status	Incorrect knowledge and poor oral health status were associated with poor oral health literacy
Richman et al (2007) USA	To develop and test an oral health literacy instrument	Parents (n=102)	As above	-REALD 99* -REALM** -OHIP-14***	REALD-99 scores and REALM scores were associated but the REALM scores were not related to dental outcomes. REALD 99 was associated with parents' oral health related quality of life.
Gong et al. (2007) USA	To develop and test the functional oral health literacy	Parents (n=102)	As above	TOFHLiD**** TOFHLA***** REALM REALD	A strong correlation was found between TOFHLiD and REALD score but correlation coefficient was less between TOFHLiD and TOFHLA and also REALM.

*REALD-Rapid Estimate of Adult Literacy in Dentistry
**REALM-Rapid Estimate of Adult Literacy in Medicine
***OHIP- Oral health impact profile
**** TOFHLiD- Test of Functional Health Literacy in Dentistry
***** TOFHLA- Test of Functional Health Literacy in Adults

Author and year	Primary objective	Participants	Definition adopted	Instruments used	Key Results
Macek et al. (2009) USA	To describe the conceptual knowledge of health literacy and to develop a new instrument using the developed framework	Adults (n=100)	As above	-CMOHK- 44****** - REALM - Short TOFHLA	Oral health knowledge scores were not associated with reading comprehension (short TOFHLA) or number of dental visits. Association was found between REALM and CMOHK 44.
Sabbahi et al. (2009) USA	To develop an instrument to assess literacy related skills in oral healthcare context. Also to find the relation between limited oral health literacy and oral health knowledge.	Adults (n=100)	As above	- OHLI - Oral health knowledge test -TOFHLA	OHLI instrument is valid (Cronbach's alpha> 0.7) and scores were significantly correlated with TOFHLA and oral health knowledge test.
Atchinson et al. (2010) USA	To develop an instrument incorporating dental and medical terms in one.	Adults (n=200)	As above	REALM-D	Participants with English as second language had significantly lower score. Ethnicity, Education and first language were identified as the predictor of health literacy.
Parker and Jamieson (2010) Australia	To determine oral health literacy and oral health related outcome associations.	Indigenous Adults (n=468)	As above	REALD-30 Self-reported oral health status questionnaire	Oral health literacy scores were related to oral health literacy related outcomes which in turn associated with problem based dental service utilisation, poor oral health knowledge, and sub-optimal oral healthcare behaviour.
Lee et al. (2011) USA	To determine the impact of oral health literacy in periodontal health.	Adults (121)	As above	REALD-30 Periodontal health score	Both bivariate and multivariable analysis indicated the association between oral health literacy and poor overall periodontal health status.

****** CMOCK-44 Comprehensive measure of oral health knowledge

Author and year	Primary objective	Participants	Definition adopted	Instruments used	Key results
Lee et al. (2012)	To measure the association between oral health literacy and dental neglect and we explored whether self-efficacy mediated or modified.	Females (1280)	As above	REALD-30	High oral health literacy was associated with better oral health status but not with dental neglect.
Sistani et al. (2013) Iran	To develop a functional oral health literacy instrument for adults with items for decision making skills.	Adults (97)	As above	OHL-AQ******	The developed instrument was valid and reliable (Cronbach's alpha-0.72) measure for functional oral health literacy. The participants who brushed more frequently had more oral health literacy scores.
Sistani et al. (2013)	The study aimed at whether oral health literacy is independent of other oral health determinants, as a risk indicator for self-reported oral health	Adults (1031)	"The process of acquiring oral health information, appraising its concepts and applying oral health prevention and treatment plans appropriately requires new skill development called oral health literacy".	OHL-AQ	Low oral health literacy was a predictor of poor self-reported oral health independent of participants' education and other socioeconomic factor.
Atchinson et al. (2014)	To determine the association of personal characteristics and a person's oral health literacy in university dental clinic.	Adults (200)	Oral health literacy is the "degree to which individuals have the capacity to obtain, process. And understand basic oral health information and services needed to make appropriate health decisions"	REALM-D	The adults who use fewer sources of oral health information, a subset of health literacy skills are frequently missing dental appointments.

******OHL-AQ Oral health literacy –Adults questionnaire

2.4.1.1 Word Recognition Instrument

REALD-30, REALD-99 and REALM-D are three word recognition instruments developed to measure oral health literacy in adult populations. They were developed from the general health literacy instrument REALM (Rapid Estimate of Adults Literacy in Medicine). The core concept for all the word recognition instruments is asking participants to read a list of commonly used words in dentistry. The words were taken from the "American Dental Association Glossary of Common Dental Terminology", and were listed in the order of increasing difficulty. The participants were asked to read out loud in front of a trained interviewer, so that they could be scored on the basis of how perfectly they could pronounce the words. The participants were instructed to read the words for which they believed they knew the correct pronunciation. The exclusion criteria for the study participants were total illiteracy and inability to speak English. REALD-30 was the first instrument developed for measuring oral health literacy, and has a vocabulary of 30 words whereas the REALD-99 instrument has 99 words. These Oral Health Literacy instruments were developed and validity was tested by administering validated general health literacy instruments such as REALM to the same participants. Scores were then correlated to determine the reliability and validity of the developed instruments.

REALD-30 was tested on 202 participants recruited from university dental hospitals (Jessica Y Lee, Rozier, Daniel.Lee, Bender, & Ruiz, 2007). The data collection included REALD-30 and REALM read aloud by participants to interviewers, TOFHLA (a functional health literacy questionnaire in medicine), and a 14 items questionnaire regarding the self-perceived dental health status measured on a Likert Scale. The validity of REALD-30 was measured by comparing the scores with the REALM score. The results indicated that REALD-30 has a good convergent validity which was 0.86 for REALM and 0.64 for TOFHLA. The results showed that health literacy was positively related to oral health related quality of life and in contrast, REALD-30 was not associated with self-perceived dental health status. This result indicated that word recognition on its own is not enough for an understanding of individual oral health literacy. Anyone with good oral health literacy might be expected to have good knowledge of self-perceived dental health status but in that study the association was not found. Another reason for this finding could be that the use of a convenient sample selection in a healthcare setting resulted in participants that were higher users of healthcare and healthcare materials that made it easier for them to read the list of words given but they were unaware of their oral health status because of lower oral health literacy.

REALD-99 is a longer version of REALD-30 and it was developed to increase the chance of measuring oral health literacy accurately (Richman et al., 2007). In Richman et al.'s (2007) study, participants' oral health outcome measures were collected and compared with the oral health literacy scores. The study was also conducted in a university setting the same as Lee et al.'s (2007) study, but the participants were the parents of paediatric patients, where the patients were aged 15 or less. An average of 84% of participants read the dental terms correctly but it was unclear whether the participants understood the meanings of the words they read correctly. The instruments had good validity and reliability but the instruments were no longer a valid measure of oral health literacy because the definition of oral health literacy had changed and extended beyond simply recognising vocabulary (Richman et al., 2007).

REALM-D was the first instrument developed that combined both oral health and the general health. The instrument used in K. A. Atchison, Gironda, Messadi, and Der-Martirosian (2010) study was a combination of the REALM and REALD-30. In this study participants (n=200) were adult patients seeking dental treatment for the first time. The selection of population was a limitation in this study and random selection of participants would have enhanced the study result. The final scores for the non-Whites were significantly lower when compared to the Whites and only 19% of the participants read the full word list correctly. The authors indicated that the instrument would be useful in clinical settings to identify the difference between the people from English and non-English speaking background (K. A. Atchison et al., 2010). This is a major limitation of the study because it would be easier for any healthcare professional to differentiate between English and non-English speaking patients without a need for a lengthy word recognition instrument.

2.4.1.1.1 Limitations of word recognition instruments

The majority of oral health literacy studies conducted so far used REALD-30 as a measuring tool for calculating the level of oral health literacy (see Table 10). Even though this instrument is a highly adopted instrument for measuring oral health literacy, some authors have indicated REALD 30 is not a realistic instrument for this purpose (Eleanor J Parker & Jamieson, 2010). Lee et al. (2007), the authors who developed REALD-I, recognised that the lack of a comprehension test was a limitation of the instrument. REALM-D and REALD-99 are the other word recognition oral health literacy instruments which require participants to read out the list of given words (K. A. Atchison et al., 2010; Richman et al., 2007). The greatest drawback for these instruments is the possibility of response bias because reading a list of English words would be easier to pronounce for people whose first language is English but may be more difficult for non-English speakers or those for whom English is a second language. There is also the possibility that participants find it difficult to read the words in the questionnaire in front of an interviewer, or healthcare provider, because of embarrassment or anxiety. The ability to pronounce certain words depends on various factors such as education level and native tongue. A word recognition instrument would also not be a useful measure for people who have difficulty speaking. The shift, however, from viewing oral health literacy as simply an ability to read oral health materials to a concept of functional health literacy has reduced the usefulness of word recognition instruments.

Even though many studies have adopted the word recognition instrument for measuring oral health literacy, in the current study pre-validated instruments developed for the adults population were not used, because, participants in the current study were adolescent children who were non-English speakers.

2.4.1.2 Instruments developed to measure functional health literacy

Studies on word recognition instruments demonstrated that oral health literacy cannot be measured by reading a list of words and later an instrument based on TOFHLA was developed for dentistry (TOFHLiD). Gong et al. (2007), who developed the TOFHLiD, indicated that functional literacy in dentistry might not be captured using a word recognition instrument (Gong et al., 2007) because to understand participant's functional health literacy numeracy and comprehension skills need to be measured.;. The main objective for Gong et al.'s study was to develop a functional health literacy instrument. The instrument was developed using TOFHLA as a template and it contained reading comprehension and numeracy sections separately. Reading comprehension was measured by using three passages regarding follow up instructions for caregivers, consent for the dental treatment, and a description of Medicaid rights and responsibilities (Gong et al., 2007). The words from the selected sentences were omitted and participants were asked to find the missing words from the sentences provided to measure their reading comprehension skills. Numeracy was measured by 12 questions that used labels from fluoridated toothpastes, paediatric appointment cards, and prescription labels. To test the construct validity, additional tests such as TOFHLA, REALM and REALD-99 were also administered to the same participants (Gong et al., 2007). The developed instrument had good convergent validity but the discrimination validity between TOFHLA (the instrument for health literacy) and TOFHLiD (the instrument for dental literacy) was poor. The validation results of this instrument did not recommend the questionnaire for widespread use in clinical or research settings because of the very low internal consistency. The author suggested a further conceptual framework to improve the instrument (Gong et al., 2007). The idea of measuring comprehensive knowledge as one of the domains of oral health literacy has been adopted from Gong et al.'s 2007 study for the current study.

2.4.1.3 Oral health knowledge as a predictor of oral health literacy

The Institute of Medicine's expert panel views health knowledge as a predictor of health literacy and others also believe health knowledge as a predisposing factor for health literacy (Dania A Sabbahi, Lawerence, Limeback, & Rootman, 2009). Later, Sabbahi et al (2009) developed an instrument with both a comprehension and numeracy test and identified the role of oral health knowledge in determining the level oral health literacy in an individual. The oral health literacy instrument developed for adults in the study by Sabbahi et al (2009) consisted of both comprehension and numeracy. The reading comprehension section was a 38-item test with words omitted from two passages about dental caries and periodontal diseases. The numeracy sections contained 19 items relating to instructions given after tooth extraction, dental prescriptions, and clinical appointments. The oral health knowledge was extended to include the relationship between oral health knowledge and oral health literacy. The scale reliability tested using Cronbach's alpha (0.898) was good. There was a strong positive correlation (0.573, $p<0.001$) between oral health knowledge scores and oral health literacy scores. The overall results indicated the developed instrument to be valid and reliable for the future use.

The same study results showed that the participants scored high oral health literacy scores but very low oral health knowledge scores (Dania A. Sabbahi, Lawrence, Limeback, & Rootman, 2009). This suggests that the developed oral health knowledge questionnaire was more difficult than the oral health literacy questionnaire. The questions to test oral health knowledge required identification of anatomical structures such as the *uvula* and *composite fillings* which need expert knowledge. An oral health knowledge test should aim to test only the participants' knowledge of healthy oral behaviours and attitudes for good oral health but with less difficult questions than those asked in this study. This study showed a strong association between oral health literacy, comprehension, and numeracy skills for oral health knowledge which indicates that oral health knowledge is a strong predictor of oral health literacy. For this reason, an oral health literacy questionnaire should have an oral health knowledge section, and in this thesis, oral health knowledge items were included, using multiple choice questions.

2.4.1.4 Disease Prevention, Self-Management and Decision-Making as a predictor of oral health literacy

Macek et al. (2010) developed a conceptual oral health knowledge instrument to use in oral health literacy research and in so doing this study introduced a theoretical pathway that linked health literacy with oral health decision- making and outcomes. The instrument contained 20 basic oral health knowledge items (each with eight elements on the prevention and management of dental caries), periodontal disease, and oral health cancer. Data were collected from 100 participants. The REALM and short-TOFHLA were also administered to test for validity and reliability. Reliability was supported by a high Cronbach's alpha value (0.74) and there was a statistically significant association between REALM and the developed instrument with good criterion validity. The study identified that a basic knowledge of oral health, dental caries prevention and management, periodontal disease prevention and management, and oral cancer prevention and management are important domains for an oral health knowledge questionnaire (Macek et al., 2010). Based on the study results, the authors provided a conceptual framework for oral health literacy via four components, namely: word recognition, reading comprehension, conceptual knowledge, and communication skills. On the basis of these findings, these concepts were adapted in this study and questions related to these domains were included in the questionnaire. Rather than measuring oral health knowledge as a separate instrument, oral health knowledge was considered as one of the domains in measuring oral health literacy. Macek et al (2010) recommended for future studies to measure the patient's ability to participate in healthcare decisions and therefore questions to measure self-managing skills and decision making attitudes were included in the current study.

2.4.2 Level of Oral health literacy

2.4.2.1 Oral health literacy in adults

The studies which are included in Table 13 all use the same widely accepted definition for oral health literacy. The common finding of the studies tabulated is that the average oral health literacy level among the adult population appears to be low (K. A. Atchison et al., 2010; Baker, 2006; Brennan, Spencer, & Roberts.Thomson, 2010; K. Jones, 2014; M. Jones et al., 2007; J. Lee, Stucky, Rozier, Lee, & Zeldin, 2013; Jessica Y. Lee et al., 2011; Macek et al., 2010; Rubinelli, Schulz, & Nakamoto, 2009; Taylor et al., 2005).

There is a strong correlation between oral health literacy and the oral health status and in turn oral health outcome. Generally, female participants tend to have a higher oral health literacy compared to the male participants (M. Jones et al., 2007; Macek et al., 2010; Dania A Sabbahi et al., 2009). A statistically significant association was identified between the education level and the level of oral health literacy (K. A. Atchison et al., 2010; Baker, 2006; Brennan et al., 2010; K. Jones, 2014; M. Jones et al., 2007; J. Lee et al., 2013; Jessica Y. Lee et al., 2011; Macek et al., 2010; Rubinelli et al., 2009; Taylor et al., 2005). Participants with university education had higher oral health literacy compared to others (Lee, et al., 2007; Macek, et al., 2010; Richman, et al., 2007; Sabbahi, et al., 2009).

Older adults had a lower level of oral health literacy compared to younger adults (Eleanor J. Parker et al., 2012). Participants with higher household income had better oral health literacy compared to others (Lee, et al., 2007; Macek, et al., 2010; Richman, et al., 2007; Sabbahi, et al., 2009). The indigenous population in Australia had poorer oral health literacy compared to non-indigenous people in Australia (Eleanor J Parker & Jamieson, 2010). The oral health literacy studies involving parents of children show a participation rate of a significantly higher proportion of female parents compared to male parents (Gong et al., 2007; Rothe, Kebriae, Pitner, & Balluff, 2009).

2.4.2.2 Oral health literacy in adolescents

A literature search for oral health literacy in adolescents resulted in only one study being identified, and it was conducted in Japan (Ueno et al., 2013). The purpose of the study was to determine the effectiveness of mouth drawing as a visual oral health literacy instrument by comparing the oral health literacy before and after oral health education in adolescents. In this study, children were asked to draw a picture of their own front teeth and gingiva from what they could see in the mirror. They were told to focus only on the anterior teeth and gingiva. In addition an intraoral digital photograph of each participant was also taken (Ueno et al., 2014). Later, an oral health education programme that consisted of a detailed explanation of healthy teeth and gingiva, dental caries and gingivitis, symptoms, treatment and prevention of dental diseases, as well as the importance of self-checking for early signs of dental diseases was emphasised. The oral health education programme was interactive, using visual aids (such as picture slides). After 20 minutes of oral health education, children were asked to draw a picture of their anterior teeth and gingiva, in just the same way as for the first mouth drawing (Ueno et al., 2014).

The participants were asked which one was better and gave them three choices: “first drawing”, “second drawing” and “both are the same”. Three dentists then scored each of the drawings between 0 and 6 for teeth and gingiva, comparing the drawings with the photographs. The scores given by the dentists were compared using the kappa value (average 0.60). The mean change in teeth and the gingival score before and after oral health education were compared using a paired *t*-test. Both the teeth and gingival scores were statistically significantly ($p<0.001$) higher for the second drawings. The teeth scores were higher than gingival scores again with a significant result (Ueno et al., 2014).

The study was carefully designed to eliminate any bias. As an example, three dentists scored the drawing separately and the scores were compared to prevent any scoring error. The study indicates that the oral health education programme using visual aids increases oral health literacy in adolescents. The only issue found on analysing the procedure used in this study was that the dentists were not blinded to the study aim and they also knew which picture was drawn before and which one was drawn after the oral health education. That the dentists knew which was drawn before and which was drawn after oral health education while scoring the drawing could have affected the scores. The description regarding who gave the oral health education was not given by the study authors. The authors indicated that the visual questionnaire developed would be a best choice for measuring basic oral health literacy before any oral health education. In my view, the artistic merit may have differed for each participant based on a range of factors, such as the nature of school curriculum and the child’s interest and ability to draw. Hence, rather than using the participants’ drawings as the indicator of oral health literacy, it would be better to administer a short questionnaire to determine the level of oral health literacy in adolescents.

2.4.2.3 Oral Health Literacy in Parents

Eleven studies identified in the literature search assessed the effect of caregivers' literacy in determining children's oral health outcome; those studies are not included in Table 13 (Divaris, Lee, Baker, & Vann, 2011, 2012; Gussy, Waters, Riggs, Lo, & Kilpatrick, 2008; Horn, Lee, Divaris, Baker, & Vann Jr, 2012; OBrien, 2010; Okada et al., 2002; Shin et al., 2014; W.F Vann et al., 2013; W. F. Vann, Lee, Baker, & Divaris, 2010). The elven studies conducted among parents have shown that parents' oral health literacy had a multidimensional impact on oral health outcomes for infants and young children (Divaris et al., 2012; W.F Vann et al., 2013). Parents are responsible for preventing decay and caring for children's oral health in the pre-adolescent period especially in infants and pre-schoolers. This is the reason why there is such a significant body of literature that examines caregivers' oral health literacy on child health outcomes. Most of the oral health studies conducted among parents have compared the young children's oral health status and parents' oral health literacy which presupposes adolescents are expected to take care of their own oral health. At present, the literature to understand oral health literacy in children is not available. There are a couple of studies that deal with health literacy in children (Michael, Leena, & Lasse, 2013; Naito, Nakayama, & Hamajima, 2007). One of those two studies is a health literacy intervention to test the acceptability of a school based programme in oral health and the other is a systematic review to understand health literacy in the context of the child (Michael et al., 2013). This study indicates that, there is no definitive, or at least no prescriptive, definition available in the literature for health literacy in the context of children. Michael et al's (2013) study also noted that there is no evidence available regarding the level of health literacy needed for children in terms of functional, interactive and critical level of skills. This thesis proposes to fill this knowledge gap in the research.

2.4.3 Relevant Research in New Zealand

There have been few studies about health literacy in New Zealand. Korero Marama is a major New Zealand Ministry of Health study conducted in 2010 to describe the health literacy skills of the adult Maori population compared to the adult non-Maori population (Ministry of Health, 2010b). The data in this research are drawn from the 2006 Adult Literacy and Life Skills Survey which measured the literacy skill level of the New Zealand population. The findings for this study compared Maori and non-Maori by gender, age, rural and urban location, level of education, labour force status and income (Ministry of Health, 2010b). The study concluded that most Maori and Non-Maori New Zealanders (56.2%) have limited ability to obtain, process and understand basic health information and services to make informed and appropriate health decisions in healthcare settings (Ministry of Health, 2010b).

2.5 Summary

In conclusion, compared to industrialised countries the dental caries prevalence is still higher in India even though there are few interventions available to prevent disease. Alarming findings reported frequently were the percentages of untreated teeth and the contribution of the missing and decayed component to DMFT total score. These findings indicate that urgent intervention is needed to improve the oral health awareness among Indian children and adolescents to restore the affected teeth and to prevent decay in unaffected teeth. Increasing oral health literacy among the adolescent population by strengthening oral health policies would be the best intervention for the Indian population.

There are various instruments available in the literature to measure oral health literacy in adult's population. Only one study was identified for adolescent populations. The most common oral health literacy instrument used in the literature was REALD-30. Oral health literacy is comparatively higher among female population than the males. Education is a stronger predictor of oral health literacy and mostly higher for participants with university education. The studies conducted among adult populations indicated that oral health literacy is associated with oral health status. In current study, oral health literacy and dental caries status of adolescent population was measured and next chapter outlines the methods used to collect data needed to answer the research questions.

Chapter 3: Methods

3.1 Introduction

The aim of the current study was to investigate adolescent school student's oral health literacy to obtain baseline measurements with a view of recommending to Government that children's oral health literacy could be improved by implementing oral health education in the school curriculum as an early intervention strategy. As a first step, impact of oral health literacy in oral health of adolescents were measured in this study expecting the study results will be helpful to design a new oral health education module for Tamil Nadu schools. There were three research questions answered in this thesis project. The first two research questions were addressed using the oral health survey and by measuring the children's oral health literacy using a self-administered questionnaire in adolescent (12-15 year-old) school students. The third research question related to understanding the association between oral health literacy and severity of dental caries and it was answered by combining the results obtained from the first two research questions. The rationale for the selection of the methodology and the data collection procedures will be discussed in this chapter.

3.2 Study Design

In current research the first two research questions were investigated by descriptive methods and third research question was answered by investigating the possible association and relationship between oral health status and oral health literacy. A cross-sectional descriptive correlational quantitative study design was selected to answer the research questions.

Watt (1893) describes correlational research as, "Correlation studies are non-experimental as there is no direct manipulation of variables. Instead, these studies depend on the natural variation of variables within the population. The purpose of correlational analysis is to discover the direction and strength of the association between two variables". The direction of association can be positive or negative. The correlation study can inform the strength of association and correlation but not the cause of relation (Watt, 1893). The correlational study usually conducted to test the theory of relationship between two variables, in the current study the variables are dental caries and oral health literacy.

3.3 Research Questions

What is the prevalence of dental caries in 12-15 year old adolescent in Tamil Nadu?
What is the level of oral health literacy in 12-15 year olds?

The first research question was investigated by measuring a DMFT index and data needed for calculating DMFT index was collected using WHO's Oral Health survey form. A questionnaire was developed to measure the oral health literacy of adolescents to answer the second research question. The methods of selection of the sample; sampling procedures; the justification for using the WHO oral health survey form and the DMFT index; procedure for developing the oral health literacy questionnaire and its pilot testing; and the data collection methods for the oral health examination and oral health literacy survey are described in this chapter.

3.4 Sample and Sampling Process

Peter (2001) noted that any measurement of disease could be undertaken in terms of morbidity or mortality The current study was aimed at describing the morbidity of dental caries. Morbidity of disease can be conveyed in terms of incidence or prevalence. Usually incidence of a disease can be determined only using a longitudinal study with a defined time period and prevalence can be identified from a cross-sectional study undertaken at one point in time. Hence, the current study which aimed at determining the prevalence of dental caries in a sample of Tamil Nadu adolescent school students is a cross-sectional study.

The term prevalence is used to indicate the proportion of the population affected by a certain disease at a given point in time. The prevalence is of two types, namely: point prevalence and period prevalence. The current study is a cross-sectional study and therefore the point prevalence method was used. The point prevalence is defined as "the number of all current cases (both old and new) of specific diseases at one point in time in relation to a defined population" (Peter, 2001).

A cross-sectional study can be helpful to collect information existing at one point of time, relevant to the disease and its association with different variables of interest. Cross-sectional studies are used to evaluate the healthcare needs of the population, to identify a risk group within a selected population and to design appropriate intervention strategies. The first step of any cross-sectional epidemiological study should be defining the population to be studied, the place of study and the method of study.

3.4.1 Population Distribution

Peter (2001) noted that "The defined population can either be a total population in a geographic area or a representative sample taken from that population" (Peter, 2001). The current study was aimed at measuring the prevalence of dental caries in Tamil Nadu school children. The total population in this area is too large to conduct a survey to cover every child. Hence, only a sample of children from the total population was examined to determine the prevalence of dental caries.

The parents should take responsibility for oral health of children of paediatric age (that is, below 12 years) (Brown, Canham, & Cureton, 2005). Adolescents, those who are in the transitional period between childhood and adulthood are expected to take responsibility and care of their oral health. The current study is aimed at measuring the oral health literacy achieved by adolescents in their childhood years. Hence, the selected age group of the participants in the current research was 12-15 years. The Tamil Nadu State Government implemented an Act in 1992 making education compulsory until 14 years of age, which demonstrates that school is the ideal place to recruit children in this age group (Department of School Education, 2009). It also means that some 15 year old would have left the school and hence the sample would not be the representation of 15 year old in Tamil Nadu. The drop out ratio is higher among lower socioeconomic population and hence it was assumed that oral health of 15 year old that left the school would be poorer than the participant who aged fifteen years in the current study. Further explanation will be provided in the discussion chapter.

3.4.2 Place Distribution

The variation of disease frequency from place to place has been well documented and especially dental caries distribution differs internationally, nationally, by region, rural-urban and also some local variations (Dulal Das et al., 2013). The current study was aimed at identifying the urban-rural and socioeconomic variations in dental caries prevalence of adolescents. The factors such as differences in the social class, population density, levels of sanitation, deficiencies in medical care, level of education as well as other environmental factors in both rural and urban areas of any selected country contribute to these variations in prevalence of diseases. Comparing the differences between the urban and rural populations provides much important information for health policy, planning and decision makers. The current study samples were recruited from both rural and urban areas of Tamil Nadu state.

3.4.3 Selection of Districts for the Study

Chennai is a highly urbanised district in the State of Tamil Nadu and because of this it was selected for recruiting the urban sample. The Thanjavur district was selected for recruiting the rural sample because of the availability of sufficient material resources to conduct the survey, and thus it forms a convenient sample. Thanjavur is one of the least urbanised districts of Tamil Nadu State and according to the 2011 census, 65 percent of total population live in rural areas, where the main occupation is agriculture.

3.4.4 Selection of Schools

Chennai district is divided into 15 zones and 200 wards. The participants from the urban population were recruited by selecting five zones randomly and again by selecting the wards randomly within each of the selected zones. Both private and public high schools in each ward were listed and schools were approached for the permission to recruit participants.

Most of the schools in Chennai district, whether private and public, did not give permission to conduct the dental survey. In most schools, even getting an appointment to meet the head teacher/Principal became nigh impossible, even after more than five visits to the schools. Reasons given by the head teachers for not participating in the dental survey were: too busy with their regular curriculum, already had had such a dental survey in their school, teachers were busy with 10^{th} and 12^{th} standard public examination, and they were about to have an inspection from the Ministry of Education in the near future. Only four schools in urban areas agreed to participate in the survey.

The participants for the rural schools were recruited from Thanjavur district. The Thanjavur district is sub-divided into three revenue divisions namely: Thanjavur, Kumbakonam, and Pattukottai. The three revenue divisions are further sub-divided into eight Taluks (sub-divisions of a district- a group of several villages organised for revenue purposes). The high schools in each Taluk were listed separately for public and private schools and approached for the permission to do the survey. Only schools in the rural parts of Thanjavur were included in the list: the urban agglomeration of the district is located in the Thanjavur taluk and therefore schools in this area were not included in the survey because the aim was to recruit only the rural participants in the Thanjavur district. Every school which was selected randomly in the rural areas agreed to participate in the survey without any of issues that were encountered in the urban schools.

The number of schools selected by a simple random sampling was determined by the number of schools in the selected area. All high schools in the selected wards and villages were listed. A list was prepared for public and private schools separately. From these lists, one public school and one private school was selected and asked for the permission to recruit participants. It was determined that not more than 100 participants were to be recruited from a single school. The same procedure was followed in both public and private schools. In each case when a school did not give permission to recruit participants, the next school in the list was approached.

3.4.5 Selection of Classes

The procedure used in the multi-centric oral health survey (Shah et al., 2007) for the selection of class rooms within each school was also followed in the current study. If there were only one section for that age group, that class was included in the survey. If more than one section was in the required age group, a random selection method was used to further select the section to be examined. In some schools, the head teacher decided the classes and sections to be examined depending on the work load in their curriculum at the time of the survey. Although this was not an ideal process it was the only realistic way that sufficient participants could have been recruited, hence the flexible approach was adopted. It still may be considered quasi random selection because the head teachers themselves have chosen a section in each class and thus the selection criteria were almost satisfied.

3.4.6 Sampling

Cohen and Holliday (1982) discuss the methods of sampling as probability and non-probability sampling. Because the study's aim was to generalise about oral health literacy and oral health status, the probability sampling method was adapted in this study to seek representativeness of the wider population. Cohen et al. (2000) indicated that probability sampling, in contrast to non-probability sampling, has reduced risk of bias and skewedness.

There are several types of probability sampling methods namely: simple random sampling, systematic sampling, stratified sampling, cluster sampling, stage sampling, and multi-phase sampling. Stratified sampling was considered the best approach for the current study because it was intended to measure the prevalence of dental caries and oral health literacy in both rural and urban populations. Hence, a two stage stratified random sampling procedure was adopted for the current study. The schools were stratified by area (rural and urban) and, within a given area; the number of schools were selected by simple random sampling determined by the number of schools in the selected area.

3.4.6.1 Power calculation

Power analysis is defined as the process for determining the sample size for a research study. Cohen (1992) indicated that statistical power calculation uses the associations across four variables involved in the statistical interpretations namely sample size (N), significance criterion (α), population effect size (ES), and statistical power which are interrelated in any statistical model. Hence, sample size (N) should be determined with a specified power for α and ES.

In reality, however, there are many complex factors that affect the size of the sample needed for a research project, such as aim of the study and the analysis required to satisfy the aim. In the current study, two different procedures were used to determine the sample size. The first method followed Cohen's standardised guide for sample size calculation. The second method adopted the sample calculation using the formula ($n=Z^2P\ (1-P)/d^2$), (Cohen, 1992).

Each statistical test (such as *t* test, normal curve test, Chi-Square test, ANOVA and multiple regression tests) has its own population effect size (ES). Cohen (1992) has given a standardised table to calculate power and in the current study sample size was calculated using "Cohen's Table".

Because the study aim was to understand the relationship between oral health literacy and oral health status of adolescents it was proposed to undertake a regression analysis and therefore the sample required for a multiple regression analysis was calculated, according to Cohen's table. In the current research, there were seven independent variables. According to Cohen's table, the sample size needed for the test with seven variables was 726 (Effect Size=0.02; Power= 0.80; Significance criterion α=0.05).

3.4.6.2 Sample size calculation using Formula

To determine the sample size using the formula ($n=Z^2P\ (1-P)/d^2$), the level of confidence (Z), expected prevalence (p) and precision (d) were needed.

The conventional level of confidence (Z= 1.96) was chosen to present the result in 95% confidence intervals (CI). The estimated prevalence rate was not known and 0.5 was used for the calculation because it produces the largest sample needed for the study. To obtain a narrow confidence interval, (d) was decided as 0.05. The estimated sample size was 392 and it was rounded up to 400. Hence, it was decided to recruit 400 participants from rural and urban areas separately (See Table 14).

Table 14: Sample Calculation

Assumed Proportion	50% (P=0.5)
Level of confidence	95%(Z=1.96)
Confidence interval (between 5 and 10)	$\pm$7%
Estimated sample size	392

3.5 Recruitment of Participants

Adolescents from the age group 12-15 years, who consented to participate, were included in the survey. In the selected schools, the class teachers of standard VIII, IX and X were approached for obtaining consent, suitable time, suitable place and other issues relating to the survey. All students in the selected classes were surveyed and examined and data from those not eligible on grounds of age were subsequently removed on the same day. Also, the data from children who had mixed dentition were removed. Where there is a mix of permanent and deciduous (“baby” teeth) the caries index should be calculated separately; this was considered too time consuming during the analysis stage and also not important in satisfying the research aims. More than 54 survey forms were removed for this reason. Even though most 13 year olds had to be excluded because they had mixed dentition, still this age group was considered because the survey objective was also to measure the health literacy of early adolescents to ascertain what knowledge they learned and retained from their childhood.

3.6 Instrumentation

3.6.1 WHO Oral Health Survey Form

The oral examination was performed by following the procedures recommended in *Oral Health Surveys, Basic Methods 4th edition- World Health Organisation (World Health Organisation, 1997).* This manual encourages every country to conduct a standardised oral health survey which can be compared internationally across countries and regions. The data collected by following this manual would ensure data reliability and also that it were comparable within and between countries (Amrit Tewari, 1998). The results can be compared with past surveys because the majority of dental epidemiological surveys were conducted based on this manual (Srivastava, Nongkynrih, Mathur, Goswami, & Gupta, 2012).

The WHO's oral health survey manual has three sections namely: background information on methods and approaches to collect the clinical data, self-reporting of oral health and the risk factors calculated by means of a questionnaire, and a final section on data analysis and survey reporting.

The Manual for Multi-Centric Oral Health Survey compiled by (Prakash, Duggal, Mathur, & Pertersen, 2004-05) was used as a guide for the oral health survey in this study. The content of this manual was based on *WHO Oral Health Surveys, Basic Methods (4th Edition, 1997).* The modifications for this version were undertaken in consultation with, Professor Poul Erik Peterson, World Health Organisation, Geneva. This manual was a simplified version of *WHO Oral Health Surveys, Basic Methods (World Health Organisation, 1997),* which had been designed for the Indian population. The manual was used as a reference guide for any queries arising while performing the multi-centre oral health survey in India. The modified oral health survey form for children from the *Manual for Multi-Centric Oral Health Survey* was used for the oral health survey in the thesis project.

The following components were covered in the form (Appendix H):

- Survey identification and general information
- Extra oral examination
- Dentition status and dental caries
- Periodontal and loss of attachment
- Oral mucosa and enamel fluorosis

Even though all the data in the survey form were collected, only the information regarding dental caries was used for analysing the results to answer the research aims of the current thesis. The periodontal, oral mucosa and enamel fluorosis data were not used in the current research will be published elsewhere. This manual was used as a reference guide especially for sampling procedures in regards to selection of blocks, villages, schools, and also selection of the classes within a school.

3.6.1.1 DMFT Index

The DMFT index is "a numerical value describing the relative status of a population, on a graduated scale with definite upper and lower limits, designed to permit and facilitate the comparison with other populations classified by the same criteria and methods." (Peter, 2001, p. 499). The main objective of indices is to maximise the understanding of the disease process in an individual as well as in the selected population.

There are various indices to understand oral health status such as the oral hygiene index, plaque index, gingival index, dental caries index, and periodontal index. The current study was aimed at determining the association between the prevalence of dental caries and oral health literacy, hence, only the Dental Caries Index was considered for analysis.

There are numerous dental caries indices used for the assessment of permanent tooth caries namely: DMFT index (Decayed Missing Filling Teeth), DMFS (Decayed Missing Filled Surface) index, DMFSS (Decayed Missing Filled Sound Surface) index, Stone's index, Czechoslovakian caries index, Caries Susceptibility index, DMF (Decayed Missing and Filled) surface percentage index, restorative index, Modified DMFT index, caries severity index, functional measure index, Tissue health index, Dental health index, Significant caries index, and Root Caries index.

Of the indices in the above list, the DMFT index has been the most commonly used index for almost 70 years, and is recommended in WHO's "Oral health survey basic methods manual". This manual recommends all participating countries use the DMFT index because then results are standardised and it is easy to make comparisons internationally. The purpose of the manual is to assist assessing the prevalence of current oral health status and to investigate the need for oral health intervention for any selected population.

The DMFT index is defined as "the quantitative expression of person's lifetime caries experience in the permanent teeth". The letter *D* in the DMFT index indicates the number of decayed teeth, *M* indicates the number of teeth missed due to dental caries, *F* indicates the number of filled teeth and T denotes the Teeth. Hence the DMFT index will give the broad overview of a person's or population's caries experience over the period of time. The DMFT index will show the prevalence of dental caries as well as the oral health status.

The DMFT index is a modification of an earlier oral health measure: the *DMF index*, which was first introduced by Henry Klein, Carole E. Palmer and Knutson in 1938. This index was widely accepted internationally by dental epidemiologists. The *D*ecayed *M*issing *F*illed index measures dental caries destruction to teeth and provides a person's total lifetime caries experience in an easily measured way. In 1986 WHO made two modifications: *T*, which denotes the affected teeth (DMFT), and *S*, which denotes the number of tooth surfaces affected by dental caries (DMFS). When written in lower case these indices provide a measure of primary dentition health.

For measuring the *DMFS index* for each tooth, a measure of surfaces is required namely: occlusal, labial, lingual, buccal, mesial, and distal surfaces. For example, if 28 teeth are examined, the examiner has to record 80 surfaces for 16 posterior teeth, 48 surfaces for 12 anterior teeth, and 20 surfaces for 4 third molars. Hence, up to 148 surfaces would be needed to be examined to measure the DMFS index. Such a lengthy process made this index a disadvantage in major community surveys like the current research and therefore the index used in the current study was DMFT index where the oral examination involves looking at the tooth as whole but not each surface. Thus, the oral health examiner need only examine 28 teeth, not 148 surfaces.

The selected age group in the current research was 12-15 year olds and DMFT index is recommended only for the permanent tooth and for deciduous tooth *defs* index is suggested. As noted above those with mixed dentitions were excluded from the study; however, for ethical reasons, data were collected from everyone in the appropriate age group in the selected classes but then the oral health survey forms were removed after the survey had been completed whereby only the data from adolescents who had only permanent (not mixed) dentition were retained for data analysis purposes.

3.6.2 Oral Health Literacy Questionnaire Development

3.6.2.1 Meaning of oral health literacy for the current research

Oral health literacy is not just about the ability to read a set of oral health-related words; it is about having a functional set of skills to prevent and self-manage diseases. Even if the concept of what oral health literacy means remains constant, different measurement tools will be required at different ages and stages of life (Don Nutbeam, 2008). For example, knowledge about cancer would be a high requirement in a cancer patient compared to that of a cardiovascular patient. Meanwhile knowledge about dental caries and oral health literacy expected in the adolescence should be different from that expected in adults. Adolescents in the 12-15 year age bracket are expected to have certain set of oral health literacy skills to prevent dental caries. Hence, standard measuring tools such as REALD-30, REALD-99, TOFHLiD, OHLI and CMOHK which measures adults' oral health literacy would not be suitable for measuring the level of oral health literacy in adolescent Indian school pupils. Because of this an oral health literacy instrument which focuses specifically on preventing dental caries in Indian school children was developed for the current research.

Taylor et al (2005) indicated that an oral health literacy instrument should measure the relation between literacy skills and outcomes such as awareness of the importance of oral health to general health, knowledge of specific oral health behaviours, oral hygiene, disease management, and participation in screening programmes (Taylor et al., 2005). Such an instrument should be easy to use both in clinical and research contexts (Taylor et al., 2005). The instrument used in the research for this thesis was developed by adopting these concepts. The participants were adolescents aged and therefore the questions Taylor et al.(2005) suggest that relate to participation in screening programmes were not included because, that would have required some input from parents or teachers.

Health literacy is conceptualised as one domain in a theoretical model of health promotion (Don Nutbeam, 2008). It follows, therefore, that the nature of health services available as well as other health promotion activities supported by Government policy have a pronounced impact on an individual's level of health literacy (Figure 2). For example, the level of oral health literacy for an 18 year old living in New Zealand with the advantage of free school dental services from birth until should be higher than an 18 year old in India where there are not comparable oral health policies or oral healthcare. It is clear that because the level of health literacy in an individual is influenced by both government policies and health promotion activities in the community, researchers and healthcare providers must take account of this when measuring the level of health literacy in an individual. Furthermore it was an important consideration when developing the questionnaire for the thesis project.

The current thesis measured oral health literacy in relation to dental caries. The human oral cavity can be affected by numerous oral health diseases involving teeth, gums and other structures in the mouth. This research project focuses on the oral health literacy of adolescents in relation to dental caries because they are at a vulnerable stage of life for infection by dental caries. Because of this a questionnaire was developed to measure oral health literacy in relation to dental caries which is meaningful and relevant to Indian 12-15 year old school children.

Priston and Searle (2010) noted there are five domains in health literacy namely: health promotion, health protection, disease prevention, healthcare maintenance and system navigation. Based on the literature review undertaken for this thesis the characteristics of a oral health literate person is that they possess a basic oral health knowledge, an interest in achieving oral health knowledge, adopting healthy behaviour, changing the behaviour to healthy attitude, self- managing diseases, and seeking help when needed. Hence, the questionnaire used in this thesis research is based on the literature review described above and is designed to be appropriate for Tamil Nadu rural and urban adolescent school pupils to understand their oral health literacy ability to prevent and manage dental caries. The extent of oral health education acquired by adolescents in Tamil Nadu schools is not well known and one factor in the questionnaire design was the knowledge and other factors that adolescents need to know to prevent and to manage dental caries. Thus the questionnaire includes questions that relate to: basic health knowledge that is expected to be known, comprehensive knowledge that is required to understand healthcare instructions, oral health behaviours the students are likely to have, and questions on attitudes to self-management of oral health issues and towards seeking help when it is needed.

The items used in the questionnaire were taken from a number of different questionnaires and the questionnaire that was developed for the thesis research was validated by pilot testing using 100 adolescents. More information on the pilot testing component of the research is presented below. The basic oral health knowledge items relevant to adolescent were taken from Ludke's oral health literacy questionnaire (Ludke RL, Kudel I, & Weber DL, 2008), attitude and behaviour questions and sociodemographic details were taken from the WHO's knowledge attitude and practice questionnaire for children (Prakash et al., 2004-05; World Health Organisation, 1997). The new comprehensive questions were developed using past oral health literacy questionnaire as a reference. The questionnaire had six parts (see Appendix F).

- Sociodemographic details: 6 Items (1-6), not scored;
- Basic oral health knowledge: 6 Items (7-12; Score: 12)
- Oral health behaviour: 4 Items (13-16; Score: 12)
- Self-management of diseases: 3 Items (17-19; Score: 6)
- Oral health attitudes: 5 Items (20-25; Score: 10)
- Comprehensive knowledge: 5 Items (26-30; Score: 10)

3.6.2.3 Length of the questionnaire

Sudman and Bradburn (1983) indicated that the response rate is affected by the lengthy questionnaire. This study illustrated the effect of a long questionnaire compared to a shorter questionnaire among high school students. In their study, the participants' responses for questions towards the end of the longer version of questionnaire were most likely to be identical for most or all the items given. The authors suggested that towards the end of any long questionnaire designed for children, there would be a lack of discriminatory power because children tend to pick the answers without reading the questions. The study suggested that shorter version of questionnaire was suitable for children to improve the reliability. The authors recommended that the acceptable length of questionnaire should be less than 12 pages. The length of the thesiss questionnaire was six pages and this included an instruction page.

3.6.2.4 Respondent burden

To avoid partial non-completion of the self-administered questionnaire used in the thesis study, potential respondent burden was identified by literature review and from the pilot study responses. The principles of questionnaire construction were based on Borgatti's (1998) article on "Principles of Questionnaire Construction". A quasi filtering technique was used for all knowledge questions where each question had a '*don't know*' option among other possible answers to reduce the likelihood that the students would simply guess the answer for sake of completing the question. This method helped to improve the quality of findings in this thesis project. For example, 99% of participants completed 100% of items in the questionnaire and the remaining 1% had not given the response to questions such as caste and parents' education. A non-response to these questions had a very limited impact on the study results.

3.6.2.5 Translating the questionnaire to a Tamil version

The questionnaire was translated into the Tamil language and students participating in the survey were given the option answering the questionnaire in English (Appendix F) or Tamil (Appendix G). Standard translation protocols were followed in the translation process. The questions were first translated from English to Tamil by a Tamil language specialist. The translated version was backward translated into the English version by the researcher. This was undertaken to check the similarity between the original English version and the backward translated English version. The greater the similarity between these two versions, more likely the original English language wording was accurately reflected in the Tamil language version. The similarities between the two English versions were confirmed by the thesis supervisors.

3.7 Pilot Testing

Oppenheim (1992) indicated that piloting of questionnaires has several advantages in improving reliability, validity and practicability. The developed questionnaire was pilot tested and the results were used to modify the questionnaire (Appendix E).

The aims of pilot study were:

- to check the clarity of items and instructions in the questionnaire
- to check the time taken to complete the questionnaire so that this information could be given to the head teachers as part of the recruitment process
- to eliminate any difficulties in the words used in the items
- to ascertain the participants’ opinions regarding the length of the questionnaire
- to alter open ended questions so that the questionnaire had a range of options or categories for closed questions

- to find any frequently misunderstood questions, and
- to practise coding and any check any difficulties likely to be encountered in data analysis.

The process and results of pilot study for the current study is described in detail in the next section.

3.7.1 Pilot Study-Process of Recruitment

The students for the pilot survey were recruited from rural schools. Permission to conduct the survey was obtained from public and private schools. It was expected that a survey in the rural area alone would satisfy the aims of pilot survey. The age group and other recruitment processes were conducted as per the study protocol. The only eligibility criterion for the pilot study was that everyone studied at the 8^{th} and 9^{th} standard in the selected schools and they were between the age group 13 and 15 years. In the frequency analysis, 15 year-olds were not represented as permission to access students from standard 10 was not given.

(Baker, 2006) indicated that ideal sample size needed for the pilot study as 10-20% of the proposed actual sample size of the study. Hence, it was decided to do the pilot study with 100 participants. The questionnaire was given to adolescents who were asked to complete the questionnaire, and this took, on average, 15 minutes to complete. After completing the questionnaire, the students were asked their opinions about the questionnaire, for example, Could they understand the wording of the questionnaire? A cognitive debriefing protocol was undertaken during the pilot testing and this is common practice when designing new survey instruments (Civel Supplies and Consumer Production Department, 2014).

3.7.2 Pilot Study-Understanding of Study Questionnaire

Most of the students from both the English and Tamil language schools said they were comfortable with the Tamil version questionnaire. Some students for whom English is their medium of education said that they were more comfortable with English version than the Tamil format but the general observation was while helping students to complete the questionnaire that most students were using the Tamil version. Even though most of the children from English medium classes were getting clarification from the Tamil version, some English medium students mentioned that they were comfortable only with English version and as a consequence for the final study both English and Tamil versions were given to children in classes where English is the medium of education. The Tamil medium school children received only the Tamil version during the final survey.

Most of the students had difficulty understanding words such as *enamel*, or *plaque* but more explanation could not be given for those words because they were included to check oral health knowledge. The frequency analysis shows more than 70% of participants gave wrong answers for those questions. This issue decreased the reliability of the questionnaire (Cronbach's alpha-0.672) although this still demonstrates good internal consistency for the questionnaire. The questions were not removed from the final survey for two valid reasons. Those questions have been included in almost all oral health literacy questionnaires used in previous studies and also those questions were included in the WHO KAP children questionnaires. Other than these examples above, the adolescents who completed the pilot study questionnaire did not demonstrate any difficulty understanding any words or questions.

3.7.3 Pilot study-Changes to the Questionnaire Based on Pilot Survey

Based on the results of the pilot study, the following changes to the questionnaire were implemented:

Question number: 4

This question asked about the number of years of education the student had had in the current school. It was removed after the pilot survey because the researcher and the thesis supervisors determined that this information was not required.

Question number: 7

The participants did not understand some response options given: namely words such as forward class, backward class, most backward class, scheduled caste and scheduled tribes. When one teacher explained that the students were more familiar with the abbreviations FC, BC, MBC, SC and ST, rather than the expanded format, abbreviations were added in parenthesis for the final questionnaire.

Question number: 22

A considerable number of students answered *dentist* and *doctor* to this question in the space given for the *others* option and therefore in the final questionnaire *dentist /doctor* was added as another response option.

Question number: 23-28

The binary *yes* or *no* responses options were modified to a Likert scale five response options between the anchors *strongly agree* and *strongly disagree*. Some of the students selected both Yes and No options in the pilot survey. When asked, why they responded their answer was between Yes and No as they felt both ways in the past hence they answered both options. For example: in answer to the item, “brushing our teeth two times a day is not important” they felt that it was both important and also of not much importance. To avoid potential confusion, the questions were modified with a five response option Likert scale pattern between strongly agree and strongly disagree.

3.8 Survey Procedure

3.8.1 Personnel and Organisation

Oral health examinations were conducted solely by the researcher to maintain consistency in the oral examinations. Two dental house surgeons were recruited from Sree Balaji Dental University to assist the researcher, organising and recording data during the survey.

The selected assistants had completed their posting in the Community Dental Department, Sree Balaji Dental University and had prior experience in school dental check-ups. The researcher provided them with a copy of the *Manual for Multi-Centric Oral Health Survey* to each assistant one week prior to the survey and they were asked to read the manual. At a meeting prior to the survey, one of the assistants was appointed as a recording clerk and another as an organising clerk. To speed up the process their positions were not changed throughout the survey.

The recording clerk's role was to record in tidy printing dental data as the researcher assessed each adolescent's teeth. The clerk was required to practise the terms used in the survey form, so that obvious mistakes made by the examiner could be recognised and corrected. The examination and calibration were practiced with 10 subjects prior to the survey. A preliminary examination was conducted prior to actual survey to practice recording the findings onto the form. An interval of at least a few days was given between training and calibration to allow the recording clerk to assimilate knowledge of the indices and to practise the procedures.

The codes used for recording were same as that indicated in *Manual for Multi-Centric Oral Health Survey* (Prakash et al., 2004-05) (Table 15)

Table 15: Criteria for Diagnosis and Coding

Conditions	Permanent Teeth	Primary Teeth
Sound	0	A
Decayed	1	B
Filled and decayed	2	C
Filled and no decay	3	D
Missing due to caries	4	E
Missing, any other reason	5	-
Sealant Varnish	6	F
Bridge abutment	7	G
Unerrupted tooth	8	-
Excluded tooth	9	-
Trauma (Fracture	T	T

The organising clerk’s role was to: collect the completed questionnaires from the participants prior to their oral examination, maintain a constant flow of adolescents to the examination area, check the completed oral health forms for accuracy, and help with instruments and supplies. The organising clerk also checked the registration number on the oral health literacy questionnaire and oral health survey form and kept them together after each survey to facilitate efficient data entry. A staff member from each school assisted in organising the questionnaire completions and oral health examinations.

The researcher, a qualified dentist who is experienced in school dental services, conducted all the dental examinations following the WHO protocol detailed above. The researcher was trained in accordance with the recommended methodology for basic oral health surveys. Prior to the survey, the researcher undertook four days training with a dental epidemiologist to familiarise herself with this type of oral examination and calibration procedures as a means of enhancing the accuracy of the findings. The examinations were conducted solely by the researcher to reduce issues of inter-examiner reliability. The researcher practiced on the indices and calibration with 10 participants during the pilot survey. On the first day of the survey, 10 participants were examined both by the researcher and also by the recording and calibrating clerks who were trained dental house surgeons to understand the accuracy of the researcher's calibrating methods. The DMFT scores from the 10 subjects were compared and their results from the researcher and the two house surgeons were almost same (greater than 95%) which indicated excellent intra examiner reliability and everyone had a good understanding of the WHO oral health survey protocol.

3.8.2 Instruments and Supplies

The following instruments and supplies were used:

- Plane mouth mirrors
- Periodontal probes
- Tweezers
- Containers for used instruments, sterilised instruments and concentrated sterilising solution
- Kidney trays for instruments and gauze pieces
- Paper towels
- Gauze
- Gloves

The time allocated at each school for the clinical oral health survey was deliberately kept short. A sufficient number of instruments were available at each examination session, which avoided the need to sterilise used equipment during a session. The number of mouth mirrors and probes recommended by WHO is 30; however, 50 mouth mirrors and probes were used in this survey because it saved time. The instruments were sterilised the day before the survey at a nearby clinic or hospital and the instruments were collected on the morning of the clinical oral examination. The researcher was responsible for ensuring adherence to international standards for infection control and waste disposal. The used gauze pieces and gloves were disposed in the nearest hospital's waste disposal area, following appropriate permission from hospital management.

A few cases of chicken pox and mumps were identified during the examination and the instruments used for those subjects were kept separately, washed carefully and then chemically sterilised before returning them to the hospital for sterilisation with the rest of the instruments by autoclave sterilisation. The class teachers and school management were immediately notified and isolation from other school students was suggested. Sufficient disposal masks and gloves were available for single use to avoid potential cross infection.

3.8.3 Examination Area

The examination area at each school along with the appropriate WHO guidelines for such sites, was discussed with the head teacher when deciding the date and time for the survey. The private schools had proper facilities for clinical examinations but in almost in every public school the oral examinations were conducted outside the building. The combination of portable battery operated lights and natural lighting were used in all locations. The participants were positioned so as to receive maximum illumination and to avoid discomfort for both examiner and the participants. The chairs and examination positions were tested with the help of few students prior to beginning the oral health examination.

The furniture needed for the examination included: a table for dental instruments, a chair for the examiner and a tall chair with a back support for the students, and a table and chair for the two clerks. The furniture was pre-arranged with the school management, with special attention given to the chairs for the student and examiner.

The children were asked to complete the oral health literacy questionnaire in their class room before they went for the oral examination. The researcher was always available to the participants while they were completing the oral health literacy questionnaire to give instructions and to clarify any questions. The children were sent to the examination site with their completed questionnaire where it was collected by the organising clerk and then the student was sent to the examiner for their oral examination. After completing a short dental history, the children were examined and the findings were recorded by the recording clerk. After each clinical examination, the completed oral health forms were given to the organising clerk to put with the oral health literacy questionnaire and the oral health survey forms. The two sets of data were stapled together in preparation for later data entry. The students returned to their class rooms after the organising clerk had checked the accuracy of the oral health form. After the oral health examination had been completed for each class, oral health education was provided for 15 minutes and then the students were given five minutes to ask any questions they had regarding dental issues. In the planning stages of this research project it had not been intended that any oral health education would be provided but it was requested by some head teachers and was therefore done as an act of good faith, in recognition of the schools' support. At the end of each day the researcher reviewed the assessment forms, checking completeness, accuracy and eligibility criteria. The students with dental caries and gum infections were referred to nearest primary health centre which offer free dental services in rural areas and private dental universities and government hospitals in urban areas.

3.8.4 Oral health literacy Survey Procedure

Informed consent was obtained through a signed consent form that was used alongside a separate information sheet (see Appendix I, J, H & K) for both the parents and students. The thesis study had intended to get informed consent from the parents but the school teachers of both urban and rural schools wanted to act as gatekeepers and also as proxy parents to give informed consent on the behalf of the parents. This is considered a culturally accepted approach in India and is normal practice when conducting school based research in India. Parents were notified about the oral health survey and were clearly informed of their right to withdraw their children if they did so wish. In the thesis project, no children were withdrawn by the parents of children attending either private or public schools.

The survey was anonymous, rather than confidential. In India, high importance is given to the term test results because marks obtained in those tests contribute to passing the academic year. As a result, a unique code number was given to each participant to assure them that the answers on the questionnaire were unidentifiable, and the researcher or teacher could not identify the person who answered the questionnaire and therefore their answers would not affect their academic results. The purpose of the code number was to enable linkage of each student who completed the questionnaire with their oral clinical examination results and their oral health assessment forms.

The questionnaire was distributed only after receiving consent from every participating student. The students were provided with oral instructions before they started the survey, and then they were given the opportunity to ask questions for further clarification. The questionnaire and consent forms were then distributed to each student, along with their unique code number, and students were asked to read the information and sign the consent form, before answering the questionnaire. None of the students refused consent in the selected classes and gave informed consent.

3.9 Data Management

The survey was anonymous. The oral health assessment forms and questionnaires with the same unique code number were kept together by the study's organising clerk. The forms were checked for the eligibility criteria, such as age and only permanent not mixed dentition. The completed oral health survey forms and oral health literacy questionnaires which met eligibility criteria were arranged according to their serial number and filed.

3.10 Data Analysis

1. Psychometric analysis was undertaken to check the validity and reliability of the developed questionnaire.

2. Quantitative data obtained from the study were analysed using the Statistical Package for Social Sciences (SPSS version 19). First, a descriptive analysis was undertaken, which generated tables and graphs and provided an overall description of the participants.

In order to examine the data more fully, correlations between pre-determined factors, and cross-tabulations were prepared for selected parameters and appropriate correlation statistical tests were applied to determine the level of associations, correlations and goodness of fit. Multivariable analysis was conducted by taking into account the effects of all variables on the responses of interest. Results were presented in both graphical and tabular format and subsequently interpreted in the thesis.

3.11 Consent and Ethical Consideration

3.11.1 Consent for the Project

The project required approval from the school management, the head teachers, and the parents to access the children. The proposal, questionnaire, information sheet, consent form and a copy of ethics approvals received from the Human ethics, University of Canterbury and the Institutional Review Board, Tamil Nadu, were submitted to the school management/head teachers of the selected schools. After receiving the permission from the management or the head teachers, information sheets were provided to the class teachers to distribute to the parents through the students. They were asked to return the attached consent form, if their parents wished their children to participate in the survey.

Informed consent is the agreement given by the participants after receiving information about a research project. Informed consent is not achieved by simply getting participants to sign a form; it should be a process whereby the participants understand the research as well as any risks associated with participation (Shahnazarian, Hagemann, Aburto, & Rose, 2013).

Children and adolescents are considered to be a vulnerable population and therefore they need extra protection both physically and psychologically (Shahnazarian et al., 2013). The information should be included in an informed consent are (Shahnazarian et al., 2013):

- Purpose of research
- Procedures involved in the research
- Alternatives to participation
- All foreseeable risks and discomforts to the subject
- Benefits of the research to society and possibly if any to participants
- Length of the time the participant is expected to participate

- Person to contact for answers to questions or in the event of research of a research related issues or emergency
- Statement indicating that participation is voluntary and refusal to participate will not result in consequences
- Statement regarding the participant’s rights to confidentiality and right to withdraw from the study at any time without any consequences

Information sheets were prepared separately for students (Appendix K) and parents (Appendix I) involved in the current study.

The students were provided with unambiguous and comprehensive instructions verbally before the start (Appendix K).

Consent was obtained from the parents and the adolescent participants separately. First consent forms and informations sheets for parents (Appendix J and I) were distributed to all students in the standard VII, VIII and IX in the selected schools. The adolescents, whose parents had given consent to participate in the survey were verbally informed about the study (Appendix K); and asked for their consent of participation (Appendix L), The students were given every opportunity to ask questions about the research study before giving their formal consent.

In three rural public schools and one urban public school, the head teachers acted as a gate keeper and also as a proxy parent to give informed consent on behalf of the parents. This method has been considered as a culturally accepted approach in India and has been followed in the past studies. For a small number of students, the head teacher acted as the primary guardian because of a lack of education among parents and other socio-cultural issues (For example, in Tamil Nadu, education is compulsory until 14 years of age and a few parents would not wish to send their children to school and it is head teachers’/ teachers’ responsibility for the children’s education, health and other wellbeing). In these instances, consent was obtained only from the head teachers and the student. Parents/ caregivers/guardians were notified about the oral health survey and were clearly informed of their right to withdraw if they did not wish their child to participate in the survey.

None of the parents declined oral or written consent for their children to participate in the survey.

3.11.2 Ethical Approval

Ethical approvals for the thesis project were received from the Human Ethics committee, University of Canterbury (HEC 2012/07) (Appendix M); and from the Institutional Review Board, Sree Balaji Dental University, Tamil Nadu (Appendix N).

3.11.3 Ethical Considerations followed in the Current Study

3.11.3.1 Risk in the research

There was no identified risk to either the students or teachers from the oral examination of participating students to identify their oral status and treatment needs. The mouth mirror, tweezers and gingival probes used in the survey were washed, chemically sterilised and then autoclaved before the next use to avoid any possible cross contamination and infection. Disposable gloves were used for each participant and discarded after completing the oral examination. Other equipment such as the pens and torches were disinfected using a chemical disinfectant. The infection control procedures adopted for the thesis research went beyond recommended infection control protocols to enhance the health and safety of the participants and researchers.

3.11.3.2 Confidentiality

The names of the participants were not collected and instead a unique code number was given to each participant.

In interviews, the head teachers' names were not collected. Details such as whether the data were from a public or private school and in a rural or urban area were noted by the researcher for data analysis purposes. For the purpose of acknowledging the names of participating schools in the thesis; permission was received from the participating head teachers. Most of the public schools' head teachers did not given permission to use their school's name anywhere in this research. For this reason, code words or numbers are used to identify the schools throughout the project.

3.11.3.3 Considerations given on Recruitment

All participants belonging to Standards VII, VIII, and IX from the selected schools were invited to participate in the survey and provided with consent and information sheets. To avoid inequality all students in the chosen standards completed the survey and were given an oral examination. If they did not meet the inclusion criteria then that data were subsequently removed.

3.11.3.4 Information for adolescents, parents and other carers

Consent forms and information sheets were designed separately for the adolescents, parents and teachers along with an invitation to participate in the study. It was proposed to handle the situation in which a child refused to consent, but the carer accepted, by explaining the study to the student face to face with the help of the class teacher. But such a situation was not encountered throughout the survey and all the students were happy to participate in the survey. The students and teachers were informed that if they refused to participate, or withdrew from the research, that this would not be held against them in any way.

The students were provided with unambiguous and comprehensive instructions at the start of the study. The questionnaire was designed by following three principles: asking questions relevant to the students' own experiences, avoiding leading questions, and also permitting "don't know" responses to avoid anxiety in completing the questionnaire.

3.12 Summary

The purpose of this chapter was to describe the research methods, explain the sample selection, describe the procedure used in designing the instrument, data collection procedures, data management and explain the statistical procedures used in this thesis project to analyse the data. The research results will be discussed in the next chapter.

Chapter 4: Results

The purpose of this chapter is to present the results of the thesis. The first section of this chapter presents the results of the psychometric analysis of the oral health literacy questionnaire, the response rate and sociodemographic profile of the participants. The findings relevant to each research question will be discussed under three separate sections. In each section, descriptive statistics with added explanations of outliers and missing data; bivariate results findings; and multivariable regression findings will be discussed.4.1 Psychometric analysis, sample frame and population profile

4.1.1 Psychometric analysis

Reliability tests were undertaken for the developed questionnaire for both the pilot study results and also the final survey.

The Cronbach's alpha test of internal consistency is the usual test for categorical questions with Likert scale options to measure the internal consistency of a questionnaire. The binary Kuder-Richardson formula is the ideal test of internal consistency for the scale items with dichotomous values. The study questionnaire had five different components in which basic oral health knowledge and comprehensive health knowledge were measured using 'right' or 'wrong' responses. The responses for these items were dichotomised into '1' for the correct answer and '0' for the wrong answer. Hence, the Kuder-Richardson test was applied to these scale items. The behaviour, attitude and self-management components of the study questionnaire had categorical responses and the reliability was tested using the Cronbach's alpha test.

For testing the reliability of the complete survey questionnaire with all five components, the actual multiple choice responses were used, rather than the corrected dichotomous values for the knowledge component to make the questionnaire suitable for the use of the Cronbach's alpha test.

The Cronbach's alpha test for the final survey was slightly reduced from 0.672 to 0.651 between the pilot and the final survey. When the alpha equals 1.0, it indicates that items measure only the true score and there is no error component. Usually the Cronbach's alpha value increases when the number of items in the scale increases, which indicates that the reliability of any measure increases with an increase in the number of items used. There were only 46 items in the questionnaire as it was purposely kept short to improve the response rate and decrease the possibility of missing data. A lengthy questionnaire increases the chance of non-responding in younger participants and the reasons were elaborated in the previous chapter. The Cronbach's alpha was between 0.458 and 0.692 for the individual components (see Table 16). The self-management component had very low alpha value as only 3 items were included to measure the self-managing skills. The overall alpha score demonstrated that the developed questionnaire had good internal consistency.

Table 16: Reliability Test

Item	Cronbach's alpha	Binary Kuder-Richardson
Pilot Test (complete questionnaire)	0.672	-
Final survey (complete questionnaire)	0.651	-
Basic Oral Health Knowledge	-	0.538
Behaviour	0.631	-
Attitude	0.512	-
Self-Management Skill	0.458	-
Comprehension Knowledge	-	0.692

4.1.2 Sample Frame

The Table 17 indicates the proposed sample frame and the actual sample achieved in the data collection. Owing to some permission issues as indicated in the previous chapter, the number of schools in the urban areas was not achieved as proposed. Otherwise, the sample of participants within each group namely, urban-public, urban-private, rural-public and rural-private was achieved. There was an increase in the number of participants between the proposed sample and the actual sample within each group due to the ethical consideration given during the recruitment process as described in the methods chapter that is, including every student in the research from the selected classrooms.

Table 17: Sample Frame

Grouping	Proposed Sample	Actual Sample
Districts	2	2
Urban Public School	4	2*
Urban Private School	4	2*
Rural Public School	4	4
Rural Private School	4	4
Adolescents Per School	50	50-100
Number of Adolescents in Rural schools	400	516
Number of Adolescents in Urban schools	400	458
Number of Adolescents in Private school	400	509
Number of Adolescents in Public school	400	465
Total number of children (n)	800	974

*Not achieved as proposed, see chapter 3; Page-98

4.1.3 Sample Versus Population Profile

Table 18 presents the sample demographic profile compared to the overall population characteristics of Tamil Nadu. The data for the overall adolescent population in Tamil Nadu is not available for comparison. The results indicate that the study sample matches the overall Tamil Nadu population, indicating that the sample is being representative of the total population as pertaining to caste. With regards to gender, the male population was over represented in the sample compared to the overall male to female population ratio.

There was a difference of 10% between male and female respondents in the study sample. The overall literacy rate of Tamil Nadu differed by 10% between the male and female population in the 2011 statistics. The participants were recruited from the schools which explained the decrease in the number of female population number in the sample. The Tamil Nadu education statistics indicates that the boys outnumbered the girls both at primary and upper primary levels of education even though the education has been made compulsory up to the age 14 years (Ministry of Statistics, 2012).

The parents' educational profiles indicated that the majority of fathers had a university education and the majority of mothers had the highest education level as 8th standard or lower. The mean age of the respondents was 13.95 with a SD 0.770 years (See Table 18). The mode and median age were 14 years as expected.

The caste profile indicated that the Forward Caste was under represented when compared with the total population. The sample data for Backward Caste and Most Backward Community combined (64.5%) was almost equivalent to the total population (67%). The data for fathers and mothers' jobs were collected in the study, but most of the participants did not give a proper job title. For example, many participants indicated jobs such as Labour, Agriculture and Business which made categorization unmanageable. Hence, the parents' job details were not used in analysing the data. The family income details were not asked in the questionnaire as the participants were younger adolescents and it was considered inappropriate to ask this type of information from this age group and the reliability of such information if collected was likely to be low.

There are various procedures reported in the literature to understand the income status of adolescent survey participants, but none of those procedures suited the context of this research. Instead, the public-private and urban-rural profiles were used to understand the economic status as it is obvious in the Indian context and also used in previous studies. Therefore, public-private and rural-urban categories were used in the data analysis along with other sociodemographic variables in both descriptive and inferential analyses. The public schools in Tamil Nadu attract students of a very low socioeconomic status due to the free education policy and mid-day meal policy. Owing to the high fees structure, the private schools of Tamil Nadu attract students of moderate to high socioeconomic status.

Table 18: Sociodemographic Profile of Sample and Overall Tamil Nadu Population

Category	Frequency	Percent	Tamil Nadu Total Population (%) Ministry of Home Affairs (2011)
Gender			
Male	542	55.6	50.1
Female	432	44.4	49.9
Age			
12 years	23	2.4	Data not available
13 years	224	23.0	Data not available
14 years	529	54.3	Data not available
15 years	198	20.3	Data not available
Father's/Male Guardian's highest level of education			
8th standard and below	258	26.5	
10th standard	228	23.4	
12th standard	108	11.1	Data available:
University	274	28.1	Overall Male Literacy rate: 86.8
No Father/guardian	32	3.3	
Don't know	74	7.6	
Mother's/Female Guardian's highest level of education			
8th standard and below	336	34.5	
10th standard	181	18.6	Data available
12th standard	129	13.2	Overall Female Literacy rate: 73.9
University	210	21.6	
No Mother/Guardian	15	1.5	
Don't Know	103	10.6	
Caste			
Forward Caste (FC)	60	6.2	13
Backward Caste (BC)	443	45.5	Data available as combined BC and MBC: 67
Most Backward (MBC)	198	20.3	
Scheduled Caste & Tribes (SC/ST)	273	28.0	SC:19/ST 1

4.2 Research Question:1

What is the prevalence and severity of dental caries in an adolescent population in Tamil Nadu schools?

Decay experience is expressed as the number of decayed, missing and filled teeth (DMFT scored between 0 and 32). Prevalence of dental decay is measured in adolescents who have dental caries with a DMFT value of more than 0. The severity of decay is measured by mean DMFT value, with the higher the value, the higher the severity of disease.

The comparisons and associations between different sociodemographic groups were investigated using Chi-Square test, *t*-test, ANOVA and regression analysis. The 95% confident interval was reported to assist in interpreting the significance of the results.

4.2.1 Prevalence of Dental Caries

4.2.1.1 Descriptive statistics

Table 19 indicates the frequency distribution for the prevalence of dental caries in the participants. Prevalence is calculated by number of participants who have a mean DMFT score of more than 0. In the study sample, 61.4% (n=598) of adolescents were affected by dental caries, that is had a DMFT score > 0 (see Table 19). One out of three adolescents did not have any caries experience which included decayed, missing and filled teeth.

Table 19: Percentage of Adolescents Affected by Dental caries

		Frequency	Percent
Valid	DMFT=0	376	38.6
	DMFT≥1	598	61.4
	Total	974	100.0

Table 20 presents the frequency analysis and associations using the Chi-Square test for the prevalence of dental caries and sociodemographic variables. The dental caries prevalence frequency referred to all those adolescents in a category that scored one or more on the DMFT scale. The frequency analysis indicated that the prevalence of dental caries was higher for adolescents who were: female, 14 years of age, their father's and mother's education was below 8th standard and they belonged to the community group scheduled caste and scheduled tribes. The adolescents who had the lowest prevalence of dental caries were male, 12 years of age, their father and mother had completed a university education and they belonged to the Forward Caste.

4.2.1.2 Bivariate Analysis

The bivariate analysis with Pearson Chi-square resulted in higher and significant values for all sociodemographic categories except the age (X^2 =1.802; $p>0.05$). The Chi-square value for the:

- father's education (X^2= 19.382; $p<0.005$),
- mother's education (X^2=26.512; $p< 0.005$),
- caste (X^2= 19.887; $p<0.005$),
- rural vs urban (X^2= 4.015; $p<0.05$) and
- Private-public school (X^2= 20.675; $p<0.001$) indicated a stronger correlation with the prevalence of dental caries.

These results indicate that the prevalence of dental caries in adolescents attending school is associated with their gender, parents' educational qualifications, the caste that they belong to and the type and location of the school to which they go. Even though bivariate results suggest that the prevalence of dental caries is influenced by various sociodemographic variables, individual predictors of dental caries prevalence can only be identified by a multiple regression analysis.

Table 20: Caries Prevalence Distribution within Sociodemographic Variables

Category	Total population percentage distribution (%)	Prevalence of Dental Caries in Adolescents (%) n (%)	Chi-square X^2 (significance)
Gender			
Male	542	317 (58.5)	4.364 (0.037)*
Female	432	281 (65.0)	
Adolescent age			
12 years	23	12 (52.2)	1.802 (0.615)
13 years	224	133 (59.4)	
14 years	529	333 (62.9)	
15 years	198	120 (61.9)	
Father's highest level of Education			
8^{th} standard	258	173 (67.1)	19.383 (0.002)**
10^{th} standard	228	150 (65.8)	
12th standard	108	67 (62.0)	
University	274	139 (50.7)	
No Father/guardian	32	22 (68.8)	
Don't know	72	47 (63.5)	
Mother's highest level of Education			
8^{th} standard	336	227 (67.6)	26.512 (0.000)***
10^{th} standard	181	117 (64.6)	
12th standard	129	71 (55.0)	
University	210	102 (48.6)	
No Mother/Guardian	15	12 (80.0)	
Don't Know	103	69 (67.0)	
Caste subdivision			
Forward Caste	60	31 (51.7)	19.887 (0.000)***
Backward Caste	443	249 (56.2)	
Most Backward	198	122 (61.6)	
Scheduled Caste& Tribes	273	196 (71.8)	
Geography and type of school			
Rural School	516	332 (64.3)	4.015 (0.026)*
Urban School	458	266 (58.07)	
Private School	509	278 (54.61)	20.675 (0.000)***
Public School	465	320 (68.81)	

Key: * p<0.05; ** p<0.01; *** p<0.001

4.2.1.3 Multivariable Regression Analysis

Multivariable regression analysis for prevalence of dental caries and sociodemographic variables

Logistic regression

Logistic regression analysis was chosen to further understand the previously reported associations between the prevalence of dental caries and socio demographic variables. The prevalence of dental caries was identified by the constructed dichotomous value created based on who had the caries experience (DMFT score > 0) and who did not have the caries experience (DMFT score = 0). This categorised the prevalence values as a binary outcome variable and hence, the logistic regression was undertaken. In the logistic regression presence or absence of dental caries was scored as follows: 0 = no dental caries and 1 = presence of dental caries. The logistic regression explains the probability of an event occurring, that is the probability of adolescents getting dental caries. Hence, the logistic regression is interpreted by the odds ratio, which is the likelihood ratio of getting the dental caries, in other words, whether any of the sociodemographic variables predicts the prevalence of dental caries occurring in the adolescent participants.

The Hosmer-Lemeshow goodness of fit test was used to verify the adjustment of the model (Table 21). For logistic regression, if the Chi-square value is not statistically significant then the model is deemed not be a good fit to the data. Hence, a well-fitting model should show a non-significant value on the goodness of fit test. The higher the significance value and the closer it is to 1, the better the model fitness is considered to be. The sociodemographic variables, father’s education, mother’s education and caste were categorical variables used in the analysis. Hence, the categories “8th standard” for parental education and “Backward Caste” for community were chosen as the reference categories while performing the logistic regression. The binary predictors such as gender, public-private schools and urban-rural schools were used as a dichotomous continuous variable by being given the values 0 and 1.

The Table 21 presents the Chi-Square value for the Hosmer-Lemeshow test which is not significant (X^2=4.496, p=0.810). The higher the value closer to one, demonstrates that the model prediction is not significantly different from the observed values. The beta value, standard error and Wald values indicated that the prevalence of dental caries was predicted by the caste and the type of school attended by the participants (see table 22).

The beta coefficient for the caste category is significant with the highest Wald chi Chi-square -square statistics (X=10.130; $p<0.05$) which indicates that the caste is a predictor of prevalence of dental caries when adjusting for parents' education, gender, type and location of the school. The participants from Scheduled Caste and Scheduled Tribes community were 1.713 times more likely to get dental caries than Backward Caste participants with the odds ratio (OR) being statistically significant. The confidence interval suggests that the magnitude of the effect could be anywhere from a 1.223 to a 2.399 fold increase.

The beta coefficient for the type of school indicates that the results are statistically significant (β= 0.352; $p<0.05$) when adjusting for parents' education, gender, caste and location. The OR for type of school indicates that the odds of prevalence are 1.422 times higher for adolescents going to public school rather than private school with results being statistically significant. The results indicate that the prevalence of dental caries in the adolescent age group is predicted by the type of school they go and their caste.

Table 21: Model 1: Hosmer and Lemeshow test for Goodness of Fit

Step	Chi-Square	df	Sig.
1	4.496	8	**.810**

Table 22: Model 1: Logistic Regression Analysis of Prevalence of Dental caries

	B	S.E.	Wald	Sig.	Exp (B)	95% C.I. for EXP (B)	
						Lower	Upper
Father's Education			.637	.986			
8^{th}				Reference Category			
10^{th}	.108	.203	.283	.595	1.114	.749	1.657
12^{th}	.051	.264	.037	.847	1.052	.627	1.765
University	-.057	.264	.046	.830	.945	.563	1.586
No father	-.032	.441	.005	.942	.968	.408	2.297
Don't Know	.053	.317	.028	.867	1.055	.566	1.964
Mother's education			4.395	.494			
8^{th}				Reference Category			
10^{th}	.051	.210	.059	.807	1.053	.697	1.590
12^{th}	-.318	.241	1.741	.187	.728	.454	1.167
University	-.353	.270	1.705	.192	.703	.414	1.193
No mother	.518	.702	.545	.460	1.679	.424	6.649
Don't Know	-.080	.274	.084	.772	.924	.540	1.581
Gender (Male-0; female-1)	.221	.139	2.520	.112	1.247	.949	1.639
Location of School (Urban -0; Rural-1)	.136	.146	.874	.350	1.146	.861	1.525
Type of School (Public -1; Private-0)	.352	.175	4.063	**.044***	1.422	1.010	2.002
Caste			10.244	**.017**			
BC				Reference Category			
FC	.124	.293	.179	.672	1.132	.637	2.012
MBC	.084	.184	.208	.649	1.087	.758	1.559
SC/ST	.538	.172	9.813	**.002***	1.713	1.223	2.399
Constant	-.717	1.361	.278	.598	.488		

Key: * $p < 0.05$; ** $P < 0.005$

4.2.1.3.1 Regression equation

Another model (see Tables 23 and 24) was generated by forcing only the type of schools and caste as the predictors by omitting other variables which had a non-significant beta value in the first model. The second model was used to derive the regression equation (see below) for prevalence of dental caries to include more accurate beta values in the final equation. The second model indicated that model fitness was good (X=3.431; p>0.634) with a significant Wald ratio for caste and type of schools (see Table 24). The result denotes that MBC and Scheduled caste/Scheduled Tribes are more likely to get dental caries than Backward Caste participants and also public school students are more likely to get dental caries than private school students.

Log (p/1-p) = 0.528 public school -0.057 Forward Caste +0.78 Most Backward Caste+ 0.584 Scheduled Caste/Tribes

Table 23: Model 2: Hosmer - Lemeshow Test for Goodness of Fit

Step	Chi-square	df	Sig.
1	3.431	5	.634

Table 24: Model 2: Logistic Regression for Prevalence of Dental Caries

	B	S.E.	Wald	Sig.	Exp (B)	95% C.I. for EXP(B)	
						Lower	Upper
Constant	.055	.109	.257	.612	1.057		
Type of School (Public-1;Private-0)	.528	.141	14.12	**.000****	1.696	1.288	2.234
Caste			13.29	**.004***			
FC	-.057	.279	.042	.837	.944	.547	1.630
BC	Reference Category						
MBC	.078	.180	.186	.666	1.081	.759	1.539
SC/ST	.584	.168	12.07	**.001***	1.793	1.290	2.493

4.2.2 Severity of Dental Caries in Adolescents

4.2.2.1 Descriptive statistics

The prevalence of dental caries indicates only the percentage of adolescents affected by the dental caries and who have the disease. In order to examine the severity of dental caries, mean DMFT values can be calculated. In this section, the frequency distribution for DMFT values and their association with socio demographic variables will be presented based on both bivariate and multivariable analyses.

Table 25: Central Tendency for DMFT score, Missing Teeth, decayed Teeth and Filled Teeth

	DMFT Score	Decay	Filled	Missing
Range	0-9	0-9	0-2	0-2
Mean	2.03	2.01	.02	.01
Median	1.00	1.00	.00	.00
Mode	0	0	0	0
Std. Deviation	2.300	2.296	.194	.085

The Table 25 shows that the mean DMFT value is 2.03 (n=974) which is the most commonly used method for describing the central tendency of a distribution. The ranges for DMFT and decayed teeth are 0-9; and for filled and missing teeth the ranges are 0-2. The median is the score found at the exact middle of the set of values and median for both DMFT and decayed teeth is 1. The median value for filled and missing teeth is 0. The results indicate that the decay component contributes more to the DMFT score than the filled and missing teeth component. The mode is the most frequently occurring value in the set of scores and the mode value for DMFT, decayed, filled and missing teeth is 0. The standard deviation (SD) value shows the relation that a set of scores has relative to the mean value of any sample. Table 25 indicates that the SD values are much closer to the mean values for all four components. This result suggests that there are minimal numbers of outliers in the sample for all four components separately. The sample with fewer outliers helps to produce accurate inferential statistics. The complete set of values for the central tendency measures suggests generally healthy teeth in the sample.

Table 26 shows the distribution of mean DMFT scores by demographic variables. The female participants had a higher mean DMFT score compared to male participants. The mean DMFT value increased with age which was lowest for 12 year olds (1.57) and highest for 15 year olds (2.22). The mean DMFT decreased with an increase in the parents' levels of education. The participants who did not have a father or mother had highest mean DMFT when compared to other categories. The participants whose parents completed their university education had the lowest mean DMFT of all categories. The DMFT value was lower for participants' whose mother completed a university degree. The Scheduled Caste and Scheduled Tribes were more affected by dental caries with higher mean DMFT (2.64). The Backward Caste had the lowest mean DMFT value (1.65) compared to other community classes. There was a slight difference in mean for the rural (1.70) and urban school (1.65) participants. The public school (2.64) had higher mean DMFT compared to private school (2.19) participants

Table 26: Distribution of Total DMFT by Demographic Characteristics

Category	Frequency	DMFT score		Median
		Mean	SD	
All	974 (100)	2.03	2.30	1
Gender				
Male	542 (55.6)	1.76	2.12	1
Female	432 (44.4)	2.39	2.50	2
Age				
12 years	23 (2.4)	1.57	1.93	1
13 years	224 (23.0)	1.75	2.08	1
14 years	529 (54.3)	2.12	2.31	1
15 years	198 (20.3)	2.22	2.61	1
Father's/Male Guardian's highest level of education				
8th standard	258 (26.5)	2.31	2.355	2
10th standard	228 (23.4)	2.14	2.282	1.50
12th standard	108 (11.1)	2.13	2.43	1
University	274 (28.1)	1.50	2.01	1
No Father/guardian	32 (3.3)	3.16	3.15	2
Don't know	74 (7.6)	2.18	2.47	1
Mother's/Female Guardian's highest level of education				
8th standard	336 (34.5)	2.40	2.43	2
10th standard	181 (18.6)	2.03	2.33	1
12th standard	129 (13.2)	1.74	2.07	1
University	210 (21.6)	1.39	1.95	0
No Mother/Guardian	15 (1.5)	3.13	2.61	4
Don't Know	103 (10.6)	2.44	2.56	2
Community				
Forward Caste	60 (6.2)	1.70	2.21	1
Backward Caste	443 (45.5)	1.65	2.06	1
Most Backward	198 (20.3)	2.19	2.52	1
Scheduled Caste & Tribes	273 (28.0)	2.64	2.46	2
Geography and type of school				
Rural School	516 (53.0)	1.70	2.39	2
Urban School	458 (47.0)	1.65	2.24	1
Private School	509 (52.3)	2.19	2.13	1
Public School	465 (47.7)	2.64	2.47	2

4.2.2.2 Bivariate analysis: DMFT and Sociodemographic Variables

The statistical analysis of the prevalence of dental caries uses a dichotomous variable generated by recoding into two categories namely, who has the caries (1) and who does not have dental caries (0). But for an understanding of the severity of dental caries, raw data was needed which is a ‘continuous-ratio’ scale with values between 0 and 32 (number of teeth). Hence, in this section the association between DMFT and sociodemographic variables will be presented using the independent *t*-test and ANOVA tests. The independent *t*-test was used to measure the association for independent variables with two categories such as gender (male-female), type of school (private-public school) and location of school (urban-rural school). The association for categories with more than two variables namely: age, father’s education, mother’s education and caste were measured using the ANOVA test.

4.2.2.2.1 Independent *t*-test

Association between Gender and DMFT

The Levene’s test for equality of variances was used to test the assumption of homogeneity of variances (see Table 27). The F value of the Levene’s test was statistically significant (F= 26.649; $p<0.005$), which indicated that the assumption of homogeneity of variance was not met. Hence, the data result associated with the equal variance not assumed test was used to interpret the results of the *t* value.

The results concluded that the severity of dental caries differed significantly between males and females ($t= -4.189$; $p<0.005$). DMFT means for the study sample showed that females (2.39) had significantly higher DMFT value than males (1.76), that is, overall oral health was poorer in females compared to males.

Table 27: t-test results for Gender, Rural-Urban and Public-Private Categories

Category	DMFT score		Leven's Test for equality of		*t*-test for equality of means			
					Equal variance assumed		Equal variance not assumed	
	Mean	Standard deviation	F	p	t	p	t	p
Gender								
Male	1.76	2.12	26.649	.000*	-		-4.189	0.000*
Female	2.39	2.50						
Geographic location of school								
Rural School	1.70	2.39	2.706	0.10	2.521	0.01	-	
Urban School	1.65	2.24						
Type of school								
Private School	2.19	2.13	15.705	0.000*	-		-4.875	0.000*
Public School	2.64	2.47						

Key: * = p < .001

<u>*Association between rural-urban schools and DMFT values*</u>

The Levene's test for equality of variance was used to test the assumption of homogeneity of variance (see Table 27). The F value of the Levene's test was not statistically significant ($F=2.706$; $p> 0.05$) which indicates that the assumption for homogeneity of variance was met. Hence, the equal variance assumed test was used to interpret the t value.

The result indicated that the severity of dental caries significantly differed between rural and urban participants in the study sample. Hence, the mean DMFT value for adolescents in rural areas was higher (1.70) compared to urban (1.65) with results being statistically significant ($t=2.521$; $p< 0.05$). That is, overall oral health was poorer in schoolchildren who attended rural located schools compared to school children who attended urban located schools.

<u>*Association between private vs public schools and DMFT values*</u>

The Levene's test for equality of variance indicated that F value was statistically significant ($F=15.705$; $p < 0.005$) and the assumption for homogeneity of variance was not met. Hence, the equal variances not assumed test was used to interpret the results of the independent *t*-test (see Table 27).

The equality of variance not assumed test indicates that the t value is statistically significant ($t= -4.845$; $p< 0.005$). The mean DMFT value for adolescents studying in public school is higher (2.64) than private school (2.19) with results being statistically significant. That is overall oral health was poorer in school children who attended public schools compared to school children who attended private schools.

4.2.2.2.2 ANOVA test

<u>Association between age and DMFT values</u>

As there are more than two values for the age category, the ANOVA test was conducted to examine the association between the DMFT values of different age groups.

The ANOVA test (see Table 28) shows that there is no significance difference in DMFT values between different age groups ($F=1.863$; $p > 0.05$). Hence, the age of school students did not have any direct effect on caries experience. Although noted in Table 26 (Page 148) where the mean DMFT increased with age, this increase failed to reach statistical significance in our sample, although it might well be of clinical significance indicating increasing unmet clinical oral health need in the community for this age group.

Table 28: ANOVA test for age, parents' Education and Caste with DMFT values

	Sum of	df	Mean Square	F	Sig.
Age					
Between Groups	40.063	4	10.016	1.863	.115
Within Groups	5208.295	969	5.375		
Father's highest level of Education					
Between Groups	144.947	5	28.989	5.499	.000*
Within Groups	5103.410	968	5.272		
Total	5248.357	973			
Mother's highest level of Education					
Between Groups	177.324	5	35.465	6.770	.000*
Within Groups	5071.034	968	5.239		
Community					
Between Groups	178.369	3	59.456	11.375	.000*
Within Groups	5069.988	970	5.227		
Total	5248.357	973			

Key: * = $p < .001$

Association between father's level of education and DMFT value

The graph (Figure15) indicates the mean DMFT value changes with the father's highest level of education and indicates that the DMFT value decreases, that is, better oral health status, as the father's education increases. The adolescents without a father or male guardian in their home tended to have more dental decay experience. These results were confirmed again in the ANOVA test with a significant F statistic (see Table 28).

The ANOVA test resulted in a significant F statistic (5.499; $p<0.05$). The result implies that the mean value of DMFT varies significantly among different categories of the fathers' education levels.

Mother's education level and DMFT value

From the means plot (see figure 13), it can be inferred that the DMFT value is high for adolescents who do not have a mother or female guardian at home and the DMFT value is least for those whose mother who attained an university education. This result is confirmed in the ANOVA test (see Table 28) with a significant F ratio (6.770; $p<0.005$). Hence, the result shows that the mean value of DMFT varies significantly by the different education levels of the mother.

Caste and DMFT values

The means plot indicates a steep increase in DMFT scores between Backward Caste and scheduled caste/tribes. The Forward Caste had slightly higher DMFT scores than backward class participants. This difference might be due to the difference in diet as the majority of Forward Caste people eat only a vegetarian diet. The correlation between vegetarian diet and higher dental caries severity is well documented in the literature (Ferraro & Vieira, 2010; Khan, Jain, & Shrivastav, 2008; Mobley, Marshall, Milgrom, & Coldwell, 2009).The ANOVA test results (see Table 28) indicates that the results are statistically significant ($F=11.375$; $p<0.005$).

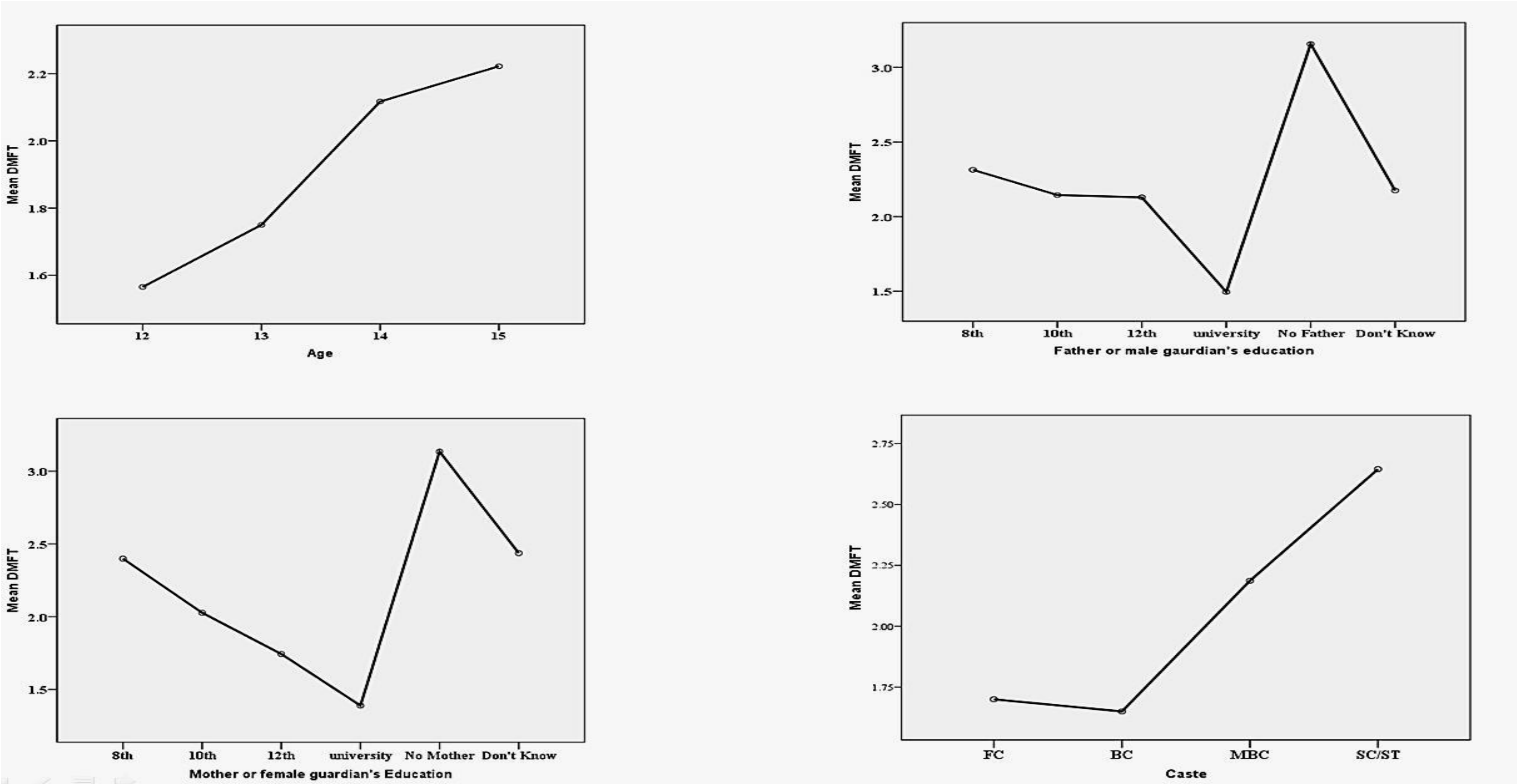

Figure 13: Mean Plots for DMFT and Age, Father's Education, Mother's Education and Caste

4.2.2.3 Multivariable analysis- severity of dental caries (DMFT)

The results of the bivariate analysis were confirmed by multivariable analysis. The DMFT score is a dependent continuous interval variable. Hence, multiple linear regression analysis was used. Even though the dependent variable was a continuous interval variable, the independent variables were categorical variables. The categorical variables had nominal or ordinal values and those must be recoded into dummy variables, because linear regression can handle only the interval or ratio level variables.

Hence, independent variables were recoded into dummy variables. The independent variables with two categories, namely, gender, private-public school, and urban-rural school were recoded into the same variable using dichotomous values “0” and “1”. For the rest of the independent variables with more than two categories, the dummy variables were created for each category. For example, the caste categories, dummyFC, dummyBC, dummyMBC and dummySC/ST were created using the values “0” and “1”. Usually, a category with a maximum number of participants is used as a reference category for performing regression to avoid multi-collineiaerity and the same procedure was used. All dummy variables were forced into the final regression model.

Preliminary analyses were carried out using linear regression with each variable in turn. These all showed a significant relationship for all predictors’ variables. Hence, every predictor variables was included in the model at the same time rather than using stepwise regression methods (Field & Miles, 2010). All independent variables were entered into the equation in one step using the "forced entry approach" (Field & Miles, 2010).

The results (see Tables 29, 30 &31) indicated that the severity of dental caries is statistically significant and linearly associated with adolescents’ gender (β= -.0562; $p<0.001$), having a mother as a university graduate (β= -0.535; $p<0.05$), and belonging to the most scheduled caste and scheduled tribes (β=0.764; $p<0.001$) categories. Hence, the severity of dental caries was decreased by the mother's level of education and an increase in the severity of dental caries was predicted by being in a SC/ST category.

The F ratio for the developed model is highly significant ($F=4.572$; $p<0.001$) with the strength of 8.3%. Even though the R square value is low ($R^2= 0.083$), the highly significant p value indicates a real relationship between the significant predictors and the dependent DMFT variable.

Frost (2014) indicated that in a regression model with little variability and low R-square value there would still be a meaningful result, if the F value is significant. This can be explained by understanding the differing level of variability by assessing the precision by measuring prediction levels. Analyzing the prediction levels was considered beyond the scope of the current thesis and those analyses were not carried out.

Table 29: Model 1: Model Fitness for Multiple Linear Regressions for DMFT

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.289[a]	.083	.065	2.245

Table 30: Model 1: ANOVA Results for Multiple Linear Regressions for DMFT

Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	438.053	19	23.055	4.572	.000[b]
Residual	4810.304	954	5.042		
Total	5248.357	973			

a. Dependent Variable: DMFT

b. Predictors: (Constant): Public School, Urban Schools, Gender-Female, 12 year olds, 13 year olds, 14 year olds, 15 year olds, Father's education 8th standard, 10th standard, 12th standard, University, No Father, Don't Know; Mother's education 8th standard, 10th standard, 12th standard, University, No Mother, Don't Know.

Table 31: Multiple Linear Regression Analysis for DMFT and Sociodemographic Variables

Model	Unstandardized		Standardized	t	Sig.
	B	Std. Error	Beta		
Constant	2.184	.344		6.357	**.000****
Gender (Female 0;Male 1)	-.562	.149	-.120	-3.783	**.000****
Age					
12 years	-.690	.488	-.045	-1.414	.158
13 years	-.199	.188	-.036	-1.061	.289
14 years	Reference category				
15 years	.246	.192	.043	1.282	.200
Father's Education					
8th	-.194	.279	-.037	-.696	.487
10th	-.165	.270	-.030	-.609	.543
12th	Reference category				
University	-.246	.295	-.048	-.833	.405
No Father/Male guardian	.540	.482	.041	1.120	.263
Don't know	-.145	.372	-.017	-.390	.696
Mother's Education					
8th	Reference category				
10th	-.179	.222	-.030	-.804	.421
12th	-.411	.261	-.060	-1.576	.115
University	-.535	.294	-.095	-1.819	**.05***
No Mother/Guardian	.007	.644	.000	.011	.991
Don't Know	-.106	.284	-.014	-.374	.709
Caste					
Forward Caste	.404	.325	.042	1.242	.215
Backward Caste	Reference Category				
Most Backward Caste	.349	.199	.060	1.748	.081
Scheduled Caste/Tribes	.764	.179	.148	4.261	**.000****
School					
Location (Urban -0 Rural 1)	.141	.160	.030	.885	.376
Type of School Private 0;	.338	.187	.073	1.806	.071

Key: * = p <.05, ** = p<.01, ** = p<.001

4.2.2.3.1 Regression equation for DMFT

A multiple linear regression analysis was performed only with the predictor variables which resulted in significant beta coefficient in the first model (See Table 32). The second model was used to derive the regression equation. The predictor variables used in the second model are mother's education, caste and gender. The adjusted R square value is usually used for comparing two models with the same predictor variables because R square value increases with the increase in the number of variables. The adjusted R square values (0.066) were almost the same for both models.

Regression Equation

DMFT= 2.341 + .553 Gender + .386 MBC +.792 SC/ST - .556 Mother's Education 12th standard - .880 Mother's Education at University level

The result indicates that DMFT score decreases when there is an increase in the mother's highest level of education which is indicated by negative beta coefficient in the regression equation. Being in a Scheduled Caste/Tribes and Most Backward community increases the chances of severity of dental caries which is indicated by positive beta coefficients. A slightly higher positive beta coefficient for Scheduled Caste and Tribes than the Most Backward Caste category indicated that adolescents who belong to Scheduled Caste and Tribes are more vulnerable to dental caries. An adolescent's gender was identified as a predictor of DMFT with significant beta coefficient value. The results are statistically significant with significant F statistics ($F=8.036$, $p<0.005$) for the developed model. The beta coefficient for the forward community was positive, but the result is not significant and hence not included in the final regression equation.

Table 32: Model 2: Multiple Variable Regressions for DMFT

	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	2.341	.178		13.154	.000
Gender (F=0;M=1)	-.553	.147	-.118	-3.777	**.000****
Mother's Education					
8th Standard			Reference Category		
10th standard	-.275	.209	-.046	-1.313	.189
12th standard	-.556	.235	-.081	-2.367	**.018***
College	-.880	.210	-.156	-4.196	**.000****
No mother	.436	.599	.023	.728	.467
Don't know	-.054	.255	-.007	-.213	.831
Community					
Forward Caste	.335	.323	.035	1.036	.300
Backward Caste			Reference Category		
Most Backward Caste	.386	.196	.067	1.969	**.049***
Scheduled Caste/Tribes	.792	.177	.153	4.468	**.000****
Model Fitness	R Square=.070; Adjusted R Square= .061				
ANOVA	F= 8.036; p<0.005				
a. Dependent Variable: DMFT					
b. Predictors: (Constant), Mother's Education, gender and caste					

Key: * = p <.05, ** = p<.01, ** = p<.001

4.3 Further Important Findings in the Oral Health Survey

4.3.1 Treatment Needs

Treatment needs can be measured by the number of decayed teeth, that is, the 'D' component in DMFT values. In the current sample most of the participants had the majority of the DMFT score comprising the decayed component compared to the missing and filling components. As the surfaces of each tooth were not individually recorded in this study, hence the data for individual treatment needs such as fissure sealant requirements, one surface filling, two or more surfaces fillings, pulp care and root canal treatments, and extraction were not collected. But the study results indicated that the majority of the decay component contributed more to the DMFT average which is needed for assessing requirements for future intervention planning.

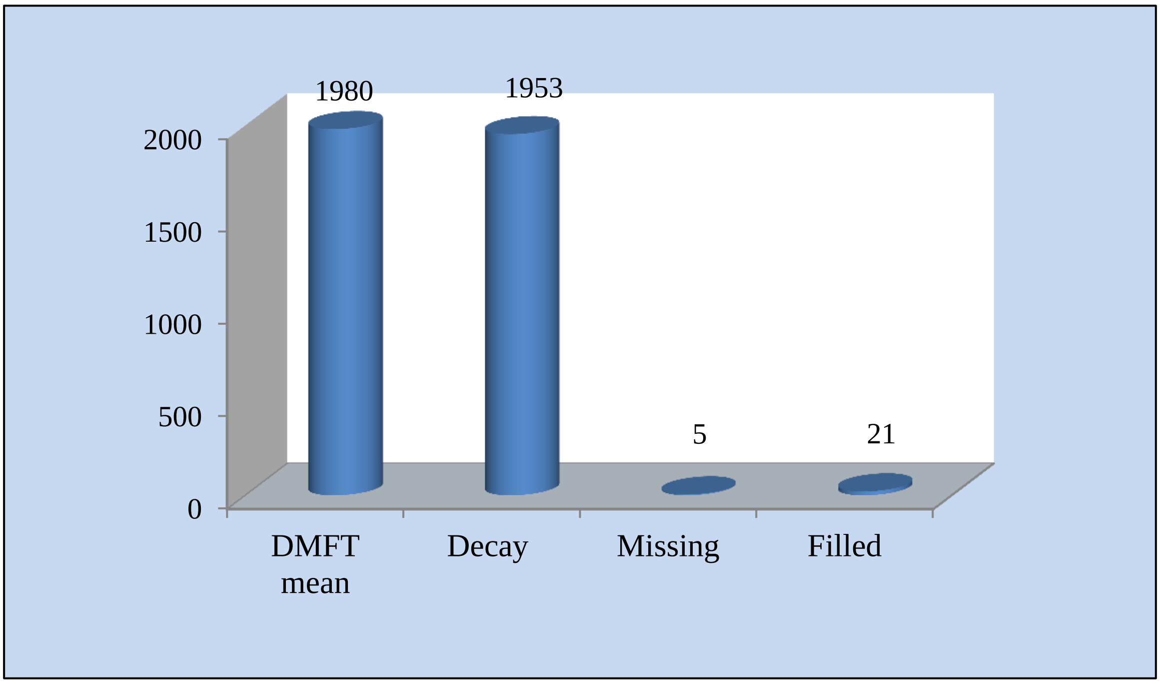

Figure 14: Contribution of Decay, Missing and Filled Components to Total DMFT Score.

Figure 14 indicates that total number of teeth affected by dental caries was 1980 in the sample population. In that, 98.6% of teeth (1953 out of 1980 teeth) were decayed and needed further treatment to protect the teeth. Only minimal numbers of teeth were filled (21 out of 1980, 1.06%). In total, twelve participants had fillings in 21 teeth and 8 participants were males out of twelve.

4.3.2 Previous Dental Visit

In the current thesis, participants were asked about their previous visit to a dentist during the oral health examination as a part of routine oral health history. Their answers were recorded in the oral health examination form even though it was not proposed originally to do so. The answers were entered as a separate variable in the spread sheet and reasons for previous dental visits were analysed for frequency distribution. In the total sample, 91% of participants reported that they never been to a dentist (see Figure 15). Only 4.1% and 2.1% of participants indicated that they been to a dentist for extraction of deciduous tooth and for orthodontic treatment or consultation respectively. Only 0.5% of participants reported that they been to a dentist for a routine check-up and scaling. The percentage of male participants (9.2%) who visited a dentist was higher than that of female participants (8.3%).

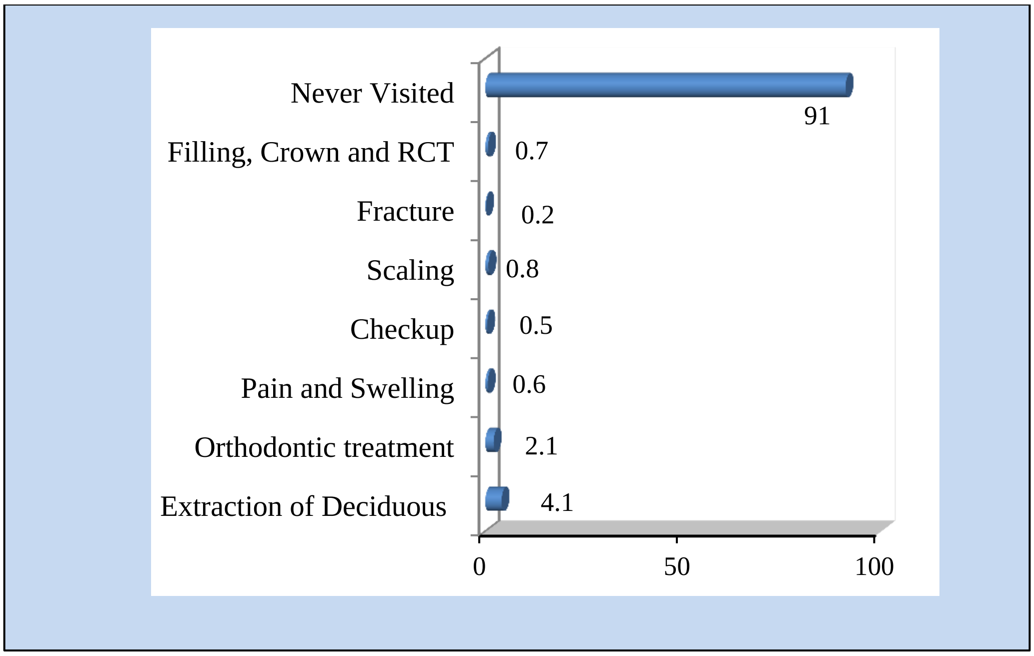

Figure 15: Previous Dental Visits

4.4 Research Question: 2

What is the level of oral health literacy in adolescents in the rural and urban schools of Tamil Nadu?

The oral health literacy of adolescent school students was measured by using a self-administered questionnaire. In the current thesis, five components were added to measure the oral health literacy namely, basic oral health knowledge, oral health behaviour, attitude towards oral health, self-managing skills and comprehensive knowledge. In this section, the results of oral health literacy measure will be discussed.

Firstly, the frequency of responses for each question will be presented. Secondly, descriptions for total score calculation and categorical score scheming will be discussed. Finally, the bivariate and multivariable results will be presented to answer the research question.

The Table 33 shows the item wise frequency responses and score contributed by each item to the final oral health literacy score. Figure 16 shows the frequency responses for some important item results.

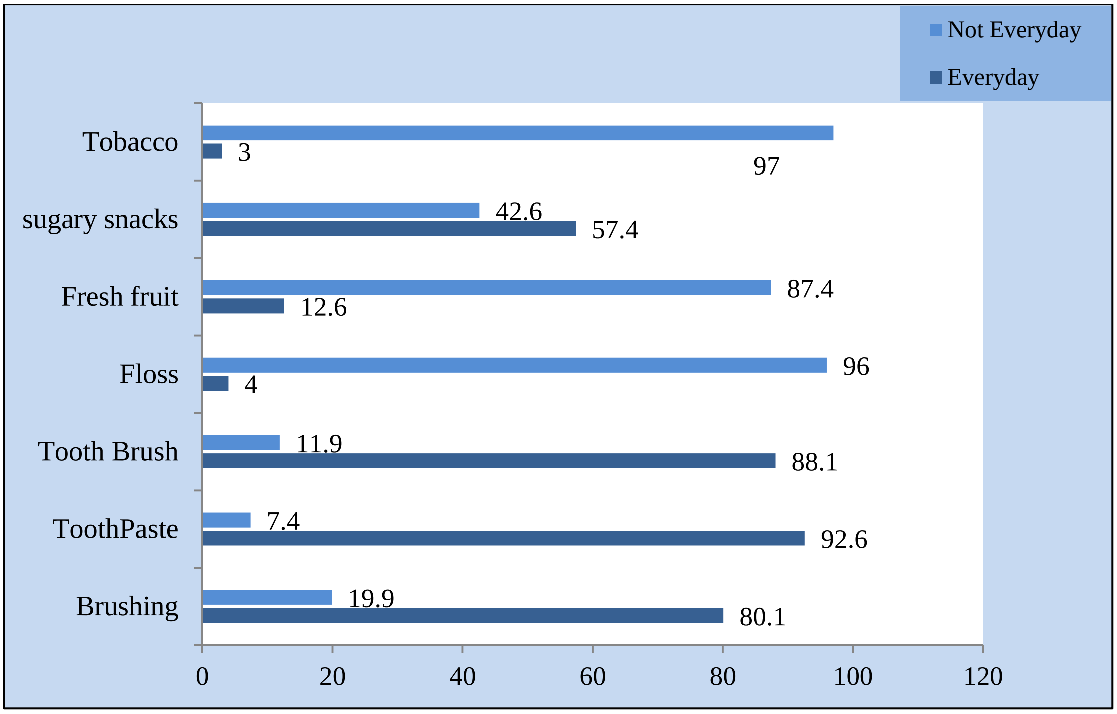

Figure 16: Frequency of Responses for Important Oral Health Behaviour

4.4.1 Frequency of responses

The frequency of individual items in the questionnaire indicated that the majority of participants lack of knowledge regarding fluorides (n= 762; 78%), plaque (n= 778; 80%) and cleaning the interdental areas of teeth (n=762; 78%). Almost 57% of participants were aware that eating sugary snacks in-between meals is not good for oral health.

Nearly 33% (n=318) of participants brushed their teeth every day and 47.5% (n=466) of participants brushed at least 2-3 times a week. Only 14% (n= 145) of participants brushed two or more times a day which is considered a standard for good oral health.

In the total sample, only 12% (n=123) of participants had access to fruits several times a day and 28.7% (n=280) of participants ate fruits at least once daily. Less than 10% of the study population reported that they did not eat any sugary snacks. Nearly 97% of participants reported that they never used tobacco. In the total study population, 3% of participants had a habit of tobacco chewing or smoking.

Even though the prevalence of dental caries in the current study is 61.4% (n=598), nearly 70% (n=680) of participants believed that they did not have tooth decay and 57.5% of them rated their oral health status between excellent and good. Up to 45.4% (n=442) of participants reported that brushing two times daily is not very important. Nearly 79% (n=749) of adolescents stated that they would like to know more about teeth and dental health.

Table 33: Frequency of Item Responses and Scores for Oral Health Literacy Questionnaire

Measure of Oral Health Knowledge

	Question	Wrong Answer	Correct answer	score
1	What is a cavity?	560 (57.5)	414 (42.5)	2
2	What is plaque?	778 (79.9)	196 (20.1)	2
3	What is enamel?	626 (64.3)	348 (35.7)	2
4	Eating sugary snacks between meals:	411 (42.2)	563 (57.8)	2
5	Important ingredient in tooth paste:	762 (78.2)	212(21.8)	2
6	How to clean interdental areas?	794 (81.5)	180 (18.5)	2

Measure of Oral Health Behaviour

	Item/option	Never	Once a week	2-6 times a week	Once a day	2 or more times	Score
7	How often do you brush your	13 (1.3)	145 (14.9)	32 (3.3)	466 (47.8)	318 (32.6)	3
8	Do you use any of the following to clean your teeth or gums?						
	Item/option	Everyday	Several times a week	Once a month	Several times a month	Never	
	Toothpaste	902 (92.6)	41 (4.2)	6 (0.6)	10 (1.0)	15 (1.5)	0.5
	Toothbrush	858 (88.1)	52 (5.3)	22(2.3)	27 (2.8)	15 (1.5)	0.5
	Wooden toothpicks	52 (5.3)	66 (6.8)	97 (10.0)	189 (19.4)	570 (58.5)	0.5
	Thread (Dental Floss)	42 (4.0)	27 (2.8)	50 (5.1)	61 (6.3)	794 (81.5)	0.5

	Charcoal/chew stick	15 (1.5)	18 (1.8)	78 (8.0)	113 (11.6)		750 (77.0)	0.5
	Tongue Cleaner	503 (51.5)	77 (7.9)	62 (6.4)	92 (9.4)		239 (24.5)	0.5
9	How often do you eat or drink any of the following foods, even in small quantities?							
	Food	Several times a	Everyday	Several	Once a week	Several times	Never	Score
	Fresh fruit	123 (12.6)	280 (28.7)	212 (21.8)	278 (28.5)	70 (7.2)	10 (1.0)	0.5
	Biscuits, cakes, wafers, buns, bread etc	202 (20.7)	357 (36.7)	160 (16.4)	178 (18.3)	44 (4.5)	33 (3.4)	0.5
	Lemonade, Mango shakes, Cola, other soft drinks, jam and honey	85 (8.6)	144 (14.8)	175 (18.0)	347 (35.6)	137 (14.1)	86 (8.8)	0.5
	Chewing gum containing sugars	88 (9.0)	107 (11.0)	119 (12.2)	188 (19.3)	115 (11.8)	357 (36.7)	0.5
	Sweets, candy, burfy, gajak etc	193 (19.8)	229 (23.5)	154 (15.8)	198 (20.3)	119 (12.2)	81 (8.3)	0.5
	Milk/ tea/coffee with sugar (Boost, complan, Milo etc)	236 (24.2)	470 (48.3)	47 (4.8)	53 (5.4)	23 (2.4)	145 (14.9)	0.5
10	How often do you use any of the following types of tobacco?	Everyday	Several times a week	Once a week	Several times a month	Never		Score
	I smoke cigarettes, pipes or cigars	5 (0.5)	0	1 (0.1)	14 (1.4)	954 (97.9)		1.5
	I use chewing tobacco or snuff	6 (0.6)	1(0.1)	5 (0.5)	29 (3.0)	933(95.8)		1.5

Measure of Self-Management

	Item/option	Excellent	Very good	Good	Average	Poor	V poor	Score
11	How would you describe health of your teeth and gum?	93 9.5%	24 2.5%	248 25.5%	297 29.6%	146 15%	166 17%	2

	item	Yes	No	Don't Know	Score
12	Do you have tooth decay?	167 (17.1)	680 (69.8)	127 (12.9)	2

		Brush/gargle	Tooth pick	Nothing	Floss	Bobby pin or	Food	Score
13	If something got stuck between your teeth, what will you do?	249 (25.2)	415 (42.6)	65 (6.7)	42 (4.3)	140 (14.4)	66 (6.8)	2

Measure of Oral Health Attitude

Q.No	Statement	Strongly agree	Agree	Neutral	Disagree	Strongly disagree	Score
14	A person should make time to see the dentist at least once a year.	510 (51.0)	267 (26.7)	118 (11.8)	34 (3.4)	67 (6.7)	2
15	It is my job to clean my teeth every day to have a nice smile.	739 (75.9)	195 (20.0)	17 (1.7)	6 (0.6)	14 (1.7)	2
16	Brushing our teeth two times a day is not important.	81 (8.3)	173 (17.8)	278 (28.5)	264 (27.1)	178 (18.3)	2
17	It is normal to get decay or tooth ache.	93 (9.5)	67 (6.9)	87 (8.9)	377 (38.7)	350 (35.9)	2

18	I would like to know more about my teeth and brushing.	328 (33.7)	421 (43.2)	153 (15.7)	45 (4.6)	27 (2.8)	2

Measure of Comprehension knowledge

Ques. No		True		False		Score
		n	%	n	%	
19	Kumar has to bite the cotton for one hour.	781	80.2	193	19.8	2
20	It is okay to eat a biscuit 30 minutes after the extraction	153	15.7	821	84.3	2
21	Kumar has to take medicine for three days	339	34.5	635	65.2	2
22	Kumar has to spit the cotton after one hour.	561	57.6	413	42.4	2
23	Kumar’s tooth was removed due to the decay.	858	88.1	116	11.9	2

4.4.2 Calculation of Scores

The items were scored based on the contribution of each component towards oral health literacy (See Table 34). Each individual item was weighed differently based on the contribution to good oral health and oral health literacy (See Table 33).

Table 34: Score Weight Given to Different Components of Oral Health Literacy

Component	Number of Item	Total score
Oral Health Knowledge	6	12
Oral Health Behaviour	4	12
Oral Health Attitude	5	10
Self-Managing Skills	3	6
Comprehensive Knowledge	5	10
Total	23	50

The scores given for each item were indicated in Table 33. Oral health knowledge and comprehension knowledge items were scored 2 for a correct answer and 0 for a wrong answer. For some behaviour and attitude questions scores were given for a correct answer as 2 and 1 for a partially correct answer. For example, brushing twice every day was considered correct behaviour and brushing once every day was considered a partially correct behaviour because brushing every day at least once is better than not brushing. Hence, to avoid decreasing the weight given to any individual component, a score of 2 was given to all correct answers in the questionnaire, including oral health knowledge and comprehension components which did not have any partially correct answer.

The answers for behaviour items were dichotomised into healthy behaviour and unhealthy behaviour before scoring them individually. The attitude questions were scored by assigning a score of 2 for responses which were considered an ideal response for preventing dental decay. The responses which have reflected a negative attitude for preventing dental decay were scored as 0 and neutral responses were scored as 1.

The scoring for self-management questions were differed from other items in the questionnaire. Before scoring the individual items in the self-management component, the responses were compared with the “Decay” scores. A cut-off to break up between poor and good oral health was decided based on the mean decay value of the total population in the current study which is 2.03. Hence, the number of decayed teeth of 3 and above was considered a poor oral health status and hence the severity of dental caries was compared with the adolescent’s opinion on their oral health status. Table 35 shows the scoring pattern for the question regarding self-perceived oral health status and self-managing ability to prevent dental decay.

Table 35: Scoring for Self-Management Items

Self- Management Measure	Decayed Score	Score
How would you describe the health of your teeth and gums?		
Participant’s answer	Actual Oral Health Status	Self-management item score
Excellent, very good, good and average	3 and above	0
Poor and very poor	3 and below	0
Excellent, very good, good and average	3 and below	2
Poor and very poor	4 and above	2
Don’t know	No score	0
Do you have tooth decay?		
Participant’s answer	Actual Oral Health Status	Self-management item score
Yes	3 or above	2
No	3 or below	2
Yes	3 or below	0
No	3 or above	0
Don’t know	No score	0
If something got stuck between your teeth, what would you do?		
Use floss to remove	Not applicable	2
Use brush to remove	Not applicable	1
Food never stuck between my teeth	Not applicable	1
I don’t do anything	Not Applicable	0
Use a bobby pin or something sharp to remove	Not Applicable	0
Use a tooth pick to remove	Not Applicable	0
Total maximum score contribution to oral health literacy		6

4.4.3 Components of Oral Health Literacy

In this section, five different measures of oral health literacy will be reported separately. The distribution of scores, comparison of means scores and distribution of scores within different sociodemographic variables will be described. The association of individual measures with total DMFT scores will be explained at the end of the section using the results of regression analysis.

4.4.3.1 Distribution of individual component scores

The Table 36 shows the frequency distribution for the scores of different components of oral health literacy and figure 19 indicates the distribution of individual scores and central tendency measures.

4.4.3.1.1 Measure of knowledge

The basic oral health knowledge of participants was measured using 6 items with a possible total correct score of 12. The figure 17 indicates the distribution of scores. The mean knowledge score of the total population was 5.68 with a standard deviation of 3.64. The result indicated that the scores were distributed with a slight positive skew with a minor difference between the mean and median (6.00). The higher standard deviation indicated that the mean score was spread out over a large range of values, indicating some students score low on these questions and some students score high on these questions.

4.4.3.1.2 Measure of oral health behaviors

The mean score was 8.13 with a standard deviation 1.278. The scores were normally distributed with a slight negative skew. The result indicated that scores were distributed very close to the mean score with less variation in mean score between cases.

4.4.3.1.3 Measure of self-management skills

The mean self-management score was 2.77 with a standard deviation of 1.56. The scores were normally distributed. The lower standard deviation indicated that the scores in the distribution were close to each other, with less spread than observed for the knowledge scores.

4.4.3.1.4 Measure of attitude

The attitude scores were distributed with a negative skew. The mean score was 8.10 which dragged into the direction of skew. For this data; median (8.00) is considered as a standard measure to understand the central tendency. The data is considered more skewed if the difference between the mean and median is higher, but the result indicates that both the mean and median are almost the same value.

4.4.3.1.5 Measure of comprehension skills

The mean score was 7.51 with data distributed with a negative skew. The value of standard deviation was 2.27. The median (8.00) is close to the mean and the result explains that the negative skew is mild and both mean and median could be used to understand the central tendency.

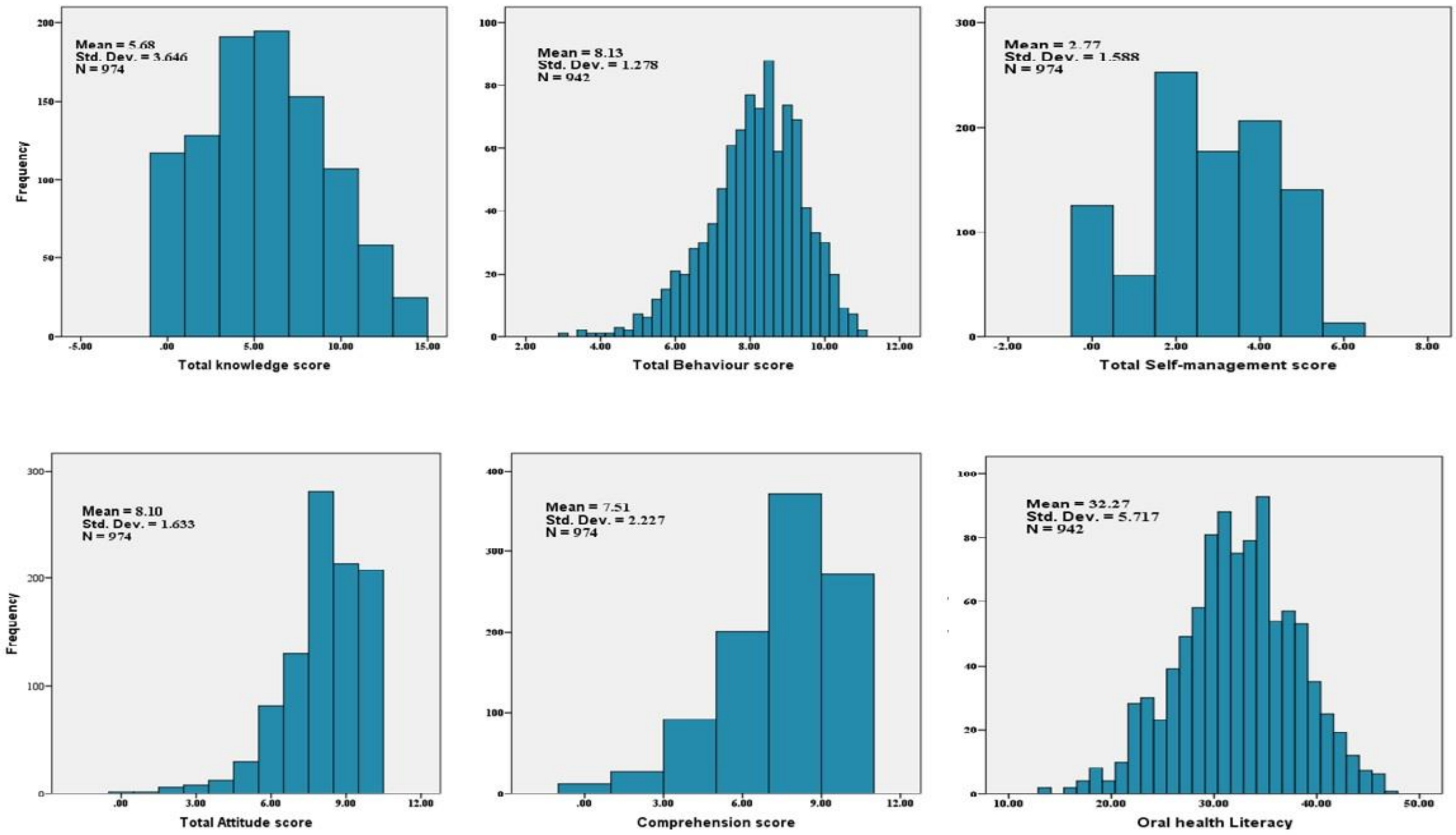

Figure 17: Distribution of Scores for Individual Components and Total Oral Health Literacy Score

4.4.3.2 Frequency distribution of components of oral health literacy within different sociodemographic variables

The comparative analysis of the mean scores of male and female participants indicated that females scored higher than male participants in knowledge, behaviour, self-management and attitude components, but the male participants scored higher on the comprehension measure (see Table 36).

The fourteen year old participants scored higher on knowledge and attitude measures and the fifteen year olds in the population scored higher for the comprehension measures. The 12 year olds scored higher score for the self-management components as the scores were calculated based on DMFT values and 12 year olds tended to have comparatively lesser decay due to newly erupted permanent teeth.

The mean scores for all individual components increased with the increase in both fathers' and mothers' levels of education. The scores for the participants whose fathers or mothers completed university education had a comparatively higher mean score for all individual components. The participants who admitted that they do not know their parents' levels of education scored the lowest mean in all the individual components.

The adolescents studying in public schools scored slightly higher in the behaviour and self-management components. The private school students scored higher in the knowledge, attitude and comprehension measures.

The urban school students scored higher in knowledge and comprehension measures but the behaviour and attitude scores were higher for adolescents attending rural schools. Self-management scores were almost equal for both urban and rural school participants. The behaviour scores were higher for rural and public school children because of the availability of sugary snacks for private and urban school students.

Table 36: Frequency Distribution of Components of Oral Health Literacy among Different Sociodemographic Variables

		Knowledge	Behaviour	Self-management	Attitude	Comprehension
Gender						
Male	Mean	5.55	7.96	2.76	8.05	7.63
	N	542	523	542	542	542
	SD	3.58	1.26	1.62	1.62	2.16
	Range	14.00	7.50	6.00	10.00	10.00
Female	Mean	5.83	8.32	2.77	8.15	7.34
	N	432	419	432	432	432
	SD	3.72	1.26	1.54	1.63	2.29
	Range	14.00	8.00	6.00	9.00	10.00
Age in years						
12	Mean	5.21	8.04	3.47	7.78	6.86
	N	23	21	23	23	23
	SD	3.50	1.21	1.23	1.90	1.98
	Range	12.00	5.75	4.00	7.00	8.00
13	Mean	5.30	8.21	2.63	8.11	7.80
	N	224	214	224	224	224
	SD	3.81	1.29	1.48	1.60	1.90
	Range	14.00	7.00	6.00	10.00	10.00
14	Mean	5.87	8.19	2.84	8.14	7.39
	N	529	512	529	529	529
	SD	3.59	1.22	1.62	1.64	2.37
	Range	14.00	7.00	6.00	10.00	10.00
15	Mean	5.62	7.86	2.63	7.99	7.55
	N	198	195	198	198	198
	SD	3.57	1.37	1.62	1.61	2.17
	Range	14.00	7.00	6.00	9.00	10.00
Father or male guardian's education						
8th	Mean	4.77	8.04	2.70	7.99	7.02
	N	258	247	258	258	258
	SD	3.20	1.21	1.564	1.78	2.37
	Range	12.00	7.25	6.00	10.00	10.00
10th	Mean	5.22	8.16	2.74	8.07	7.68
	N	228	221	228	228	228
	SD	3.22	1.18	1.62	1.53	2.10
	Range	14.00	6.75	6.00	9.00	10.00
12th	Mean	5.46	8.19	2.64	8.12	7.74
	N	108	100	108	108	108
	SD	3.64	1.29	1.70	1.72	1.97
	Range	14.00	6.00	6.00	10.00	8.00
University	Mean	7.30	8.14	2.86	8.35	7.89
	N	274	271	274	274	274
	SD	3.97	1.34	1.57	1.30	1.97
	Range	14.00	7.25	6.00	6.00	10.00

		Knowledge	Behaviour	Self-management	Attitude	Comprehension
No father/male guardian	Mean	5.18	8.13	2.56	7.62	6.93
	N	32	30	32	32	32
	SD	3.28	1.28	1.342	2.21	3.25
	Range	12.00	5.50	5.00	8.00	10.00
Don't Know	Mean	4.70	8.11	2.95	7.71	7.10
	N	74	73	74	74	74
	SD	3.18	1.39	1.59	2.11	2.40
	Range	12.00	7.75	5.00	7.00	10.00
Mother or female guardian's education						
8th	Mean	4.94	8.13	2.71	8.03	7.17
	N	336	322	336	336	336
	SD	3.16	1.19	1.59	1.62	2.33
	Range	12.00	7.25	6.00	10.00	10.00
10th	Mean	5.39	8.09	2.80	8.03	7.63
	N	181	175	181	181	181
	SD	3.68	1.21	1.58	1.49	2.17
	Range	14.00	7.00	6.00	8.00	10.00
12th	Mean	5.55	8.25	2.78	8.21	7.78
	N	129	122	129	129	129
	SD	3.42	1.33	1.70	1.63	2.12
	Range	14.00	6.75	6.00	10.00	10.00
University	Mean	7.55	8.03	2.78	8.42	7.98
	N	210	209	210	210	210
	SD	4.10	1.36	1.54	1.41	1.79
	Range	14.00	7.00	6.00	9.00	10.00
No mother/ guardian	Mean	6.40	8.57	2.53	7.86	5.86
	N	15	13	15	15	15
	SD	2.16	1.286	1.24	1.59	3.41
	Range	8.00	5.00	4.00	5.00	10.00
Don't Know	Mean	4.81	8.12	2.87	7.61	7.28
	N	103	101	103	103	103
	SD	3.18	1.39	1.58	2.11	2.40
	Range	12.00	7.50	6.00	9.00	10.00
Type of School						
Private	Mean	6.05	8.11	2.72	8.35	7.75
	N	509	500	509	509	509
	SD	4.03	1.32	1.61	1.47	1.95
	Range	14.00	7.50	6.00	10.00	10.00
Public	Mean	5.26	8.14	2.81	7.81	7.23
	N	465	442	465	465	465
	SD	3.12	1.22	1.55	1.75	2.46
	Range	14.00	8.00	6.00	9.00	10.00
Geographic location of school						
Rural	Mean	5.17	8.29	2.78	8.20	7.20
	N	516	498	516	516	516
	SD	3.33	1.18	1.55	1.63	2.36

		Knowledge	Behaviour	Self-management	Attitude	Comprehension
	Range	14.00	8.00	6.00	10.00	10.00
Urban	Mean	6.24	7.94	2.75	7.97	7.85
	N	458	444	458	458	458
	SD	3.89	1.35	1.62	1.62	2.01
	Range	14.00	6.75	6.00	10.00	10.00
Total Population	Mean	5.67	8.12	2.77	8.09	7.50
	N	974	942	974	974	974
	SD	3.64	1.27	1.58	1.63	2.22
	Range	14.00	8.00	6.00	10.00	10.00

4.5 Oral Health Literacy Scores

4.5.1 Distribution of total oral health literacy by demographic characteristics

Table 37 presents the results of mean and median of oral health literacy (OHL) total scores for different sociodemographic variables. The total oral health literacy score is normally distributed with a mean score of 32.27 and the standard deviation is 5.27. The mean score is almost equal to the median score (32.26), which are expected given the normal distribution of mean scores. The OHL score was slightly higher for female (32.36) participants compared to male participants (31.89). The adolescents who were 14 year of age had a score higher (32.37) compared to other age groups.

The mean OHL score for adolescents whose parents had university education was comparatively higher (34.50) than other categories. The participants who did not know their parents’ education qualifications (30.5) and those who reported their parents’ education level less than 8th standard had scored lower (31.00). The mean scores for participants who reported not having a father or male guardian (30.87) was noticeably lower than for participants who reported do not having a mother or female guardian (32.12) living with them. This result implies that the mother's education level has a greater impact on an adolescent's oral health literacy.

The rural school participants (31.50) scored lower than urban school (32.70) participants and private school participants (32.96) scored higher than the public school participants (31.15). The differences in the mean scores between different sociodemographic variables were very small and the standard deviations are reasonably high demonstrating a wide range in the scores and variability in the data. The statistical significance of these results may be understandable only by inferential analyses. The results of bivariate and multivariable analyses are discussed in the next section.

Table 37: Total Oral Health Literacy Scores and Sociodemographic Variables

Category	Frequency N (%)	Oral health Literacy Total Score Mean	Standard deviation	Median	Range (0 – 50)
All	974 (100)	32.10	5.77	32.25	33.50
Gender					
Male	542 (55.6)	31.89	5.463	31.87	31.50
Female	432 (44.4)	32.36	6.13	32.62	33.50
Age					
12 years	23 (2.4)	31.17	4.749	31.50	16.75
13 years	224 (23.0)	31.96	5.92	32.25	29.50
14 years	529 (54.3)	32.37	5.82	32.50	33.00
15 years	198 (20.3)	31.65	5.54	31.50	32.75
Father's/Male Guardian's highest level of education					
8th standard	258 (26.5)	30.45	5.19	30.50	29.25
10th standard	228 (23.4)	31.81	5.25	31.87	28.25
12th standard	108 (11.1)	32.02	5.44	32.00	27.25
University	274 (28.1)	34.55	5.79	34.75	29.00
No Father/guardian	32 (3.3)	30.29	6.22	31.50	28.00
Don't Know	74 (7.6)	30.57	6.47	31.12	27.25
Mother's/Female Guardian's highest level of education					
8th standard	336 (34.5)	30.90	5.37	31.00	32.25
10th standard	181 (18.6)	31.89	5.24	31.50	24.75
12th standard	129 (13.2)	32.46	5.75	32.50	28.75
University	210 (21.6)	34.76	5.83	34.87	29.00
No Mother/Guardian	15 (1.5)	30.85	5.70	32.75	20.75
Don't Know	103 (10.6)	30.67	6.06	31.25	30.75
Community					
Forward Caste	60 (6.2)	34.85	6.22	34.75	26.50
Backward Caste	443 (45.5)	33.03	5.40	33.00	28.00
Most Backward	198 (20.3)	32.17	5.68	32.75	32.00
Scheduled Caste/Tribes	273 (28.0)	29.93	5.65	30.00	27.25
Geography and Type of school					
Rural School	516 (53.0)	31.50	5.57	32.00	29.75
Urban School	458 (47.0)	32.70	5.934	32.75	33.50
Private School	509(52.3)	32.96	6.039	33.25	30.50
Public School	465 (47.70)	31.15	5.31	31.50	31.75

Key: * p < .01, ** p < .001

4.5.2 Bivariate Analysis between Oral Health Literacy Score and Sociodemographic Variables

The total oral health literacy score is a ‘continuous ratio’ scale variable with values between 0 and 50. Hence, bivariate analyses were performed using independents for sociodemographic variables which have two categories such as gender (male vs female), type of school (public vs private) and school location (rural vs urban) predictor variables. For other sociodemographic variables such as parents’ education levels and community/caste, with more than two categories per variable the association were measured using the ANOVA test.

4.5.2.1 Independent t test

The differences in mean scores within the categories of gender, geography and types of schools were tested using an independent t- test (see Table 38).

The Levene’s test for equality of variance resulted in a significant F value ($F=11.324$); $p<0.001$) for type of school. Hence, the equal variance not assumed test results were used to interpret the results for the *t*-test. The results indicated that the t value was statistically significant ($t=4.983$; $p<0.005$) which implies that the differences in mean oral health literacy scores between male and female participants were statistically significant.

The Levene’s test for equality of variance resulted in with non-significant F values for both rural-urban school location ($F=2.215$; $p> 0.05$) and gender ($F=3.338$; $p>0.05$) variables. Hence, the equal variance assumed *t*-test was used to interpret the results.

The independent *t* test results indicated that the differences in mean OHL scores between female and male participants, rural and urban ($t=3.088$; $p<0.005$) and private- public ($t=4.983$; $p<0.001$) school participants were statistically significant ($t=1.284$; $p= 0.199$).

Table 38: t-test Results for Gender, Public-Private and Rural-Urban

Category	OHL score		Levene's Test for equality of variance		*t*-test for equality of means			
					Equal variance assumed		Equal variance not assumed	
	Mean	SD	F	p	t	p	t	p
Gender								
Male	31.89	5.46	3.338	.068	1.284	.022*		
Female	32.36	6.13						
Geographic location of school								
Rural School	31.56	5.47	2.215	0.137	3.088	0.002*	-	
Urban School	32.70	5.92						
Type of school								
Private School	32.01	5.44	11.324	0.001			4.983	.000*
Public School	32.58	6.04						

Key: * p < .01, ** p < .001

4.5.2.2 ANOVA test

The Table 39 shows the results of the ANOVA test for the variables of age, community/caste and parents' highest levels of education with total oral health literacy scores. The figure 18 shows the means plotted for those categories with oral health literacy scores.

Table 39: ANOVA test results for Age, Parents' Education and Caste

	Sum of Squares	df	Mean Square	F	Sig.
Age					
Between Groups	101.727	3	33.909	1.018	.384
Within Groups	32320.903	970	33.321		
Father’s/Male Guardian’s highest level of education					
Between Groups	2636.797	5	527.359	17.138	.000*
Within Groups	29785.833	968	30.770		
Mother’s/ Female Guardian’s highest level of education					
Between Groups	2229.585	5	445.917	14.296	.000*
Within Groups	30193.045	968	31.191		
Community					
Between Groups	2123.166	3	707.722	22.657	.000*
Within Groups	30299.464	970	31.237		
Total	32422.630	973			

Key: * [$p<0.001$]

Except for the age variable the ANOVA results for all variables indicated between the group means were statistically significant. The graphical representation of the ANOVA indicated that the 14 year olds have higher oral health literacy scores than other participants but this result failed to reach statistical significance ($F=1.018$; $p<0.384$).

The graphical representation of the ANOVA indicated that the oral health literacy scores increased with the increase in the parents’ levels of education and these results were again confirmed in the bivariate analysis with significant F statistics. The F value for the father’s level of education is 17.138 with absolute significance ($p<0.001$). The F statistics for the mother’s education level was 14.296 ($p<0.001$). The result implies that the oral health literacy of adolescents is related to their parents’ education.

The graphical representation of the ANOVA for the caste oral health literacy score shows that the oral health literacy scores consistently decreased between the community Forward Caste and Scheduled Caste/Tribes. In contrast to the results for the caste to DMFT score (see Table 15); the oral health literacy score is remarkably higher for Forward Caste than Backward Caste. The results are not surprising for the Indian context because only the Forward Caste have rights for education historically when compared to other communities in India. The oral health literacy scores for the Scheduled Caste/Tribes community are comparatively lower than other communities with a score difference of ‘5’ between Forward Caste and Scheduled Caste/Tribes which is higher. These results were confirmed in the ANOVA test with a statistically significant F value ($F=22.657$; $p<0.001$).

These results will be further analysed using multivariable regression and presented at the end of this section.

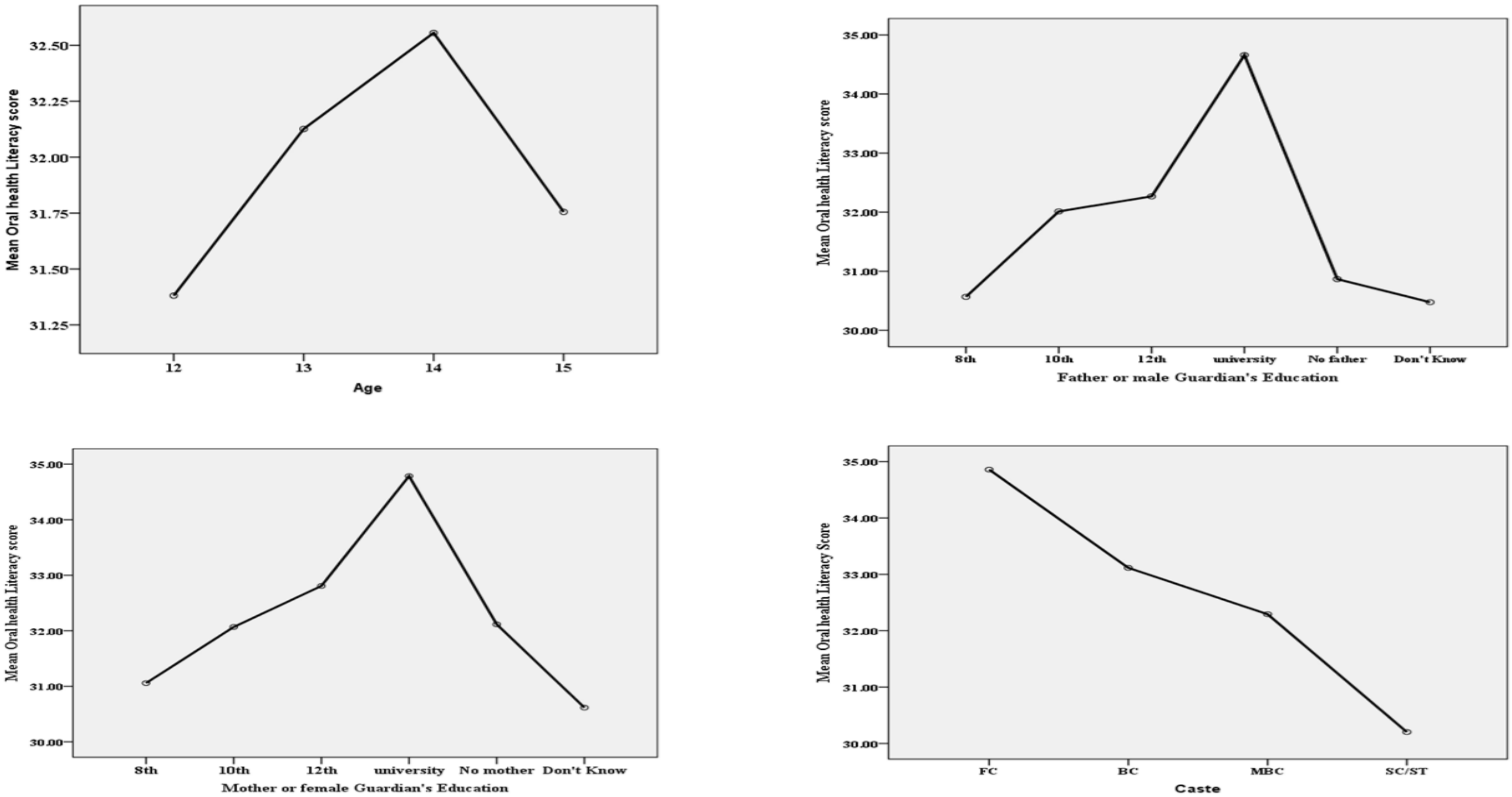

Figure 18: Mean Plots for Oral Health Literacy Scores and Sociodemographic Variables

4.5.3 Multivariable Analysis of the Oral Health Literacy Data

Linear regression between overall oral health literacy and sociodemographic variables

The multiple linear regression analysis was performed to determine which independent variables contributed significantly to explaining the variability in the dependent variable.

The oral health literacy score is a dependent variable which is a continuous and ratio variable. Hence, multiple linear regression analysis was performed. In the bivariate analysis, except for age, all independent variables were statistically significant. In the multiple regression analysis, all independent variables were added except age.

All independent variables were coded as categorical-nominal variables. The linear regression could not handle nominal variables and all categorical variables are decoded into dummy variables to convert the nominal variable to continuous variables of values ‘0’ and ‘1’. Each category within different sociodemographic variables was dichotomised into a separate dummy variable. For example, for the caste category there were four categories and each category was recoded into four dummy variables namely, dummyFC, dummyBC, dummyMBC and dummySC/ST. Each dummy variable was created using the values 0 and 1.

Usually, the category with a maximum number of participants is used as a reference category for performing regression to avoid multicollinearity and the same procedure was used. All dummy variables were forced into the final regression analysis.

Preliminary analyses were carried out using linear regression with each variable in turn. These all showed a significant relationship for all predictors’ variables. Hence, all predictor variables were included in the model at the same time rather than stepwise regression methods (Field & Miles, 2010). All independent variables were entered into the equation in one step which is called the "forced entry approach" (Field & Miles, 2010).

The result (Table 42) indicated the oral health literacy scores were significantly associated with adolescents who are male (β=-0.766; $p<0.05$), did not know their father's highest level of education (β=-1.844; $p<0.05$), whose mother has finished university education (β=1.420; $p<0.05$), and who belonged to the community Scheduled Caste/Tribes (β=-2.418; $p<0.005$). The result indicated that adolescent's oral health literacy is positively associated with the mother's level of education. Being a male participant, not knowing the father's level of education and being a Scheduled Caste/Tribes all have a negative influence on the oral health literacy scores, while the mother's level of education is positively associated with the overall OHL score.

The F ratio for the developed model is highly significant (F= 8.919; $p<0.001$) with the strength of the relationship 12.6%. Even though the R square value is low (R^2=0.112), accounting for 11% of the variance in the data, the highly significant F statistic (see Table 41) indicates the actual relationship between the significant predictors and dependent variable is real. As previously described in this chapter, a regression model with little variability and low R-square value would be still a meaningful result, if the F value is significant.

Table 40: Model Fitness for Regression Analysis for Raw Oral Health Literacy Score and Sociodemographic Variables

Model 1	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.355[a]	.126	.112	5.38668

Table 41: ANOVA Results for Mean Oral Health Literacy Score

Model 1		Sum of Squares	df	Mean Square	F	Sig.
	Regression	3881.660	15	258.777	8.918	.000[b]
	Residual	26869.155	926	29.016		
	Total	30750.816	941			

a. Dependent variable: Oral health literacy

b. Predictors: (Constant) Gender, Father's education, Mother's education, Caste and Rural- urban schools

Table 42: Regression analysis for Oral Health Literacy Score and Sociodemographic Variables

Model 1	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	33.28	.771		43.15	**.000****
Gender (Male-1, Female-0)	-.766	.359	-.067	-2.14	**.033***
Father's Education					
8^{th}	-1.19	.684	-.092	-1.75	.081
10^{th}	-.085	.667	-.006	-.127	.899
12^{th}	Reference category				
University	1.27	.724	.101	1.76	.079
No Father	-1.33	1.19	-.041	-1.12	.264
Don't Know	-1.84	.910	-.086	-2.03	**.043***
Mother's Education					
8^{th}	Reference category				
10^{th}	.176	.535	.012	.328	.743
12^{th}	.413	.633	.024	.652	.515
University	1.42	.693	.103	2.05	**.041***
No Mother	.656	1.64	.013	.399	.690
Don't Know	-.090	.685	-.005	-.131	.896
Caste					
Forward Caste	.153	.778	.007	.197	.844
Backward Caste	Reference category				
Most Backward Caste	-.320	.482	-.022	-.665	.506
Scheduled Caste/Tribes	-2.42	.437	-.188	-5.54	**.000****
School					
Rural-Urban	-.241	.371	-.021	-.649	.517
Private- Public	-.241	.447	-.021	-.539	.590

Key: * = p <.05, ** = p< .001

Regression Equation

In the previous section, for the multiple linear regression analysis for DMFT data, a smaller model was performed to derive a regression equation because only the mother's education, type of school and caste were significant in the first model. But for the oral health literacy model, almost every variable had at least one significant beta coefficient and hence, the first model was used to derive the regression equation.

Regression Equation

Oral health literacy = 33.285 – 0.766 Gender – 1.844 Do not know the father's education + 1.420 University education for mother -2.418 SC/ST

4.6 Oral health Literacy Categories

The oral health literacy scores were divided into three categories based on the literature (Jessica Y Lee et al., 2007; Dania A Sabbahi et al., 2009), the difficulty of the questionnaire and scores needed to prevent and manage dental caries. The raw oral health literacy scores were categorised into poor (<30), moderate (31-40) and good (41-50) (See Table 43, Figure 19). The adolescents are expected to have a good level of oral health literacy to prevent dental caries. This categorical understanding was needed to classify the population at risk in preventing dental decay based on oral health literacy. According to the current study, the adolescent participants who were categorized as having poor oral health literacy skills are at highest risk for preventing and managing dental caries on their own and intervention should be targeted to that group to improve their oral health literacy and prevent dental caries.

Table 43: Frequency of Categories of Oral Health Literacy Scores

	Frequency	Percent
Poor OHL	342	35.1
Moderate OHL	551	56.6
Good OHL	81	8.3
Total	974	100.0

The Chi-square analysis was performed to understand the difference in the mean scores between different categories of sociodemographic variables. The results show (see Table 44) that categorical oral health literacy has a significant association with all sociodemographic variables except for the age groups. A significant Chi-square value for their father's education (X^2=80.003; p<0.001); their mother's education level (X^2=67.492; p<0.001); and their community/caste (X^2 =63.766; p<0.001) indicated that the level of oral health literacy is strongly associated with these categories.

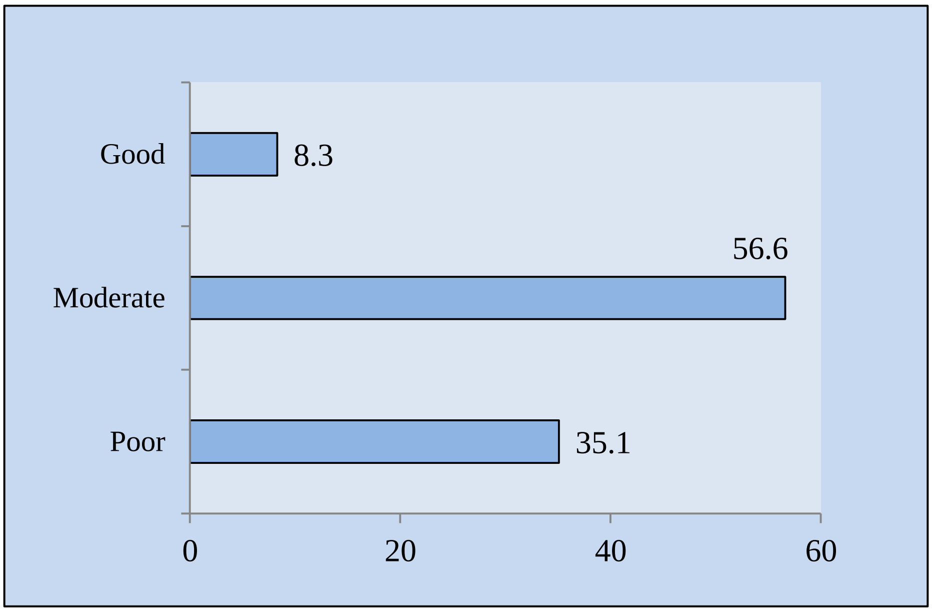

Figure 19: Percentage of Different Categories of Oral Health Literacy

The percentage of participants categorised under poor oral health literacy is higher for those attending a public school (38.9) compared to those attending a private school (31.6). The result was statistically significant (X^2 = 31.664; p<0.001).

The percentage of students attending a rural school (37.8%) who were categorised as having poor oral health literacy skills was higher than for those attending an urban school (32.1%). The percentage of participants categorised as having good oral health literacy was higher for those attending an urban school. These results were statistically significant with an absolute significant Chi-square value (X^2 =10.599; p<0.001).

Table 44: Cross-Tabulation of Oral Health Literacy Scores with Sociodemographic Variables

Category	Total n	Oral Health Literacy Poor	Moderate	Good	Chi-Square X^2 (significance)
Gender					
Male	542	205 (37.8)	301 (55.5)	36 (6.6)	6.906 (0.032)*
Female	432	137 (31.7)	250 (57.9)	45 (10.4)	
Adolescent age					
12 years	23	9 (39.1)	14 (60.9)	0	3.44 (0.751)
13 years	224	83(37.1)	121(54.0)	20 (8.9)	
14 years	529	178(33.6)	305(57.7)	46(8.7)	
15 years	198	72(36.4)	111(56.1)	15(7.6)	
Father's highest level of Education					
8th standard	258	119 (46.1)	135 (52.3)	4 (1.6)	80.00 (0.000)**
10th standard	228	80(35.1)	137 (60.1)	11 (4.8)	
12th standard	108	41(38.0)	58 (53.7)	9 (8.3)	
University	274	62(22.6)	160 (58.4)	52 (19.0)	
No Father/Guardian	32	12(37.5)	19 (59.4)	1 (3.1)	
Don't Know	72	28(37.8)	42 (56.8)	4(5.4)	
Mother's highest level of Education					
8th standard	336	142 (42.3)	182 (54.2)	12 (14.8)	67.49 (0.000)**
10th standard	181	71 (39.2)	99 (54.7)	11 (13.6)	
12th standard	129	40 (31.00	78 (60.5)	11(13.6)	
University	210	44 (21.0)	124 (59.0)	42 (51.9)	
No Mother/Guardian	15	5 (33.3)	10 (66.7)	0	
Don't Know	103	40 (38.8)	58 (56.3)	5 (6.2)	
Caste subdivision					
Forward Caste	60	14 (23.3)	32 (53.3)	14 (23.3)	63.76 (0.000)**
Backward Caste	443	128 (28.9)	272 (61.4)	43 (9.7)	
Most Backward	198	60 (30.3)	127 (64.1)	11(5.6)	
Scheduled Caste & tribes	273	140 (51.3)	120 (44.0)	13(4.8)	
Geography and type of school					
Rural School	516	195 (37.8)	291 (56.4)	30 (5.8)	10.59 (0.005)**
Urban School	458	147 (32.1)	260 (56.8)	51 (11.1)	
Private School	509	161 (31.6)	282 (55.4)	66 (13.0)	31.66 (0.000)**
Public School	465	181 (38.9)	269 (57.8)	15 (3.2)	

Key: * = p <.05, ** = p<.001

4.7 Research Question: 3

What is the association between oral health literacy and DMFT scores?

4.7.1 Descriptive analysis

One of the main aims of the current thesis is to understand the association between oral health literacy and the severity of dental caries. The figures 20 and 21 clearly suggest that the severity of dental caries and the prevalence of dental caries are associated with oral health literacy scores. The adolescents who scored higher and were grouped as having good oral health literacy skills had lesser decay compared to adolescents in other categories (see Figure 20). This result was confirmed using bivariate and multivariable regression analysis to understand the correlations and to know whether oral health literacy is one of the predictors of dental caries.

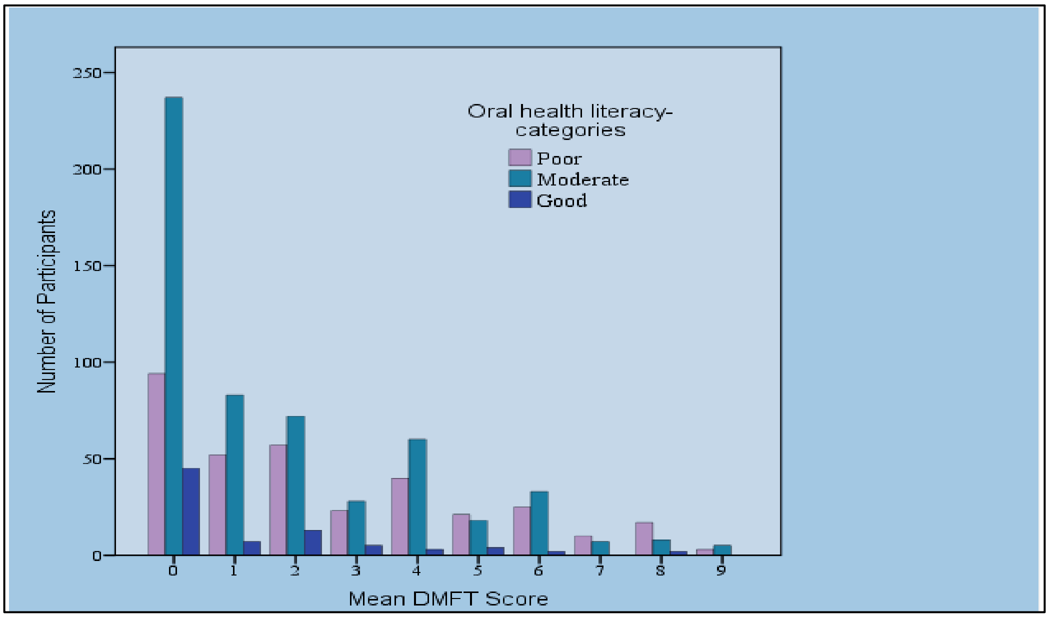

Figure 20: Association between DMFT and Oral health Literacy Scores

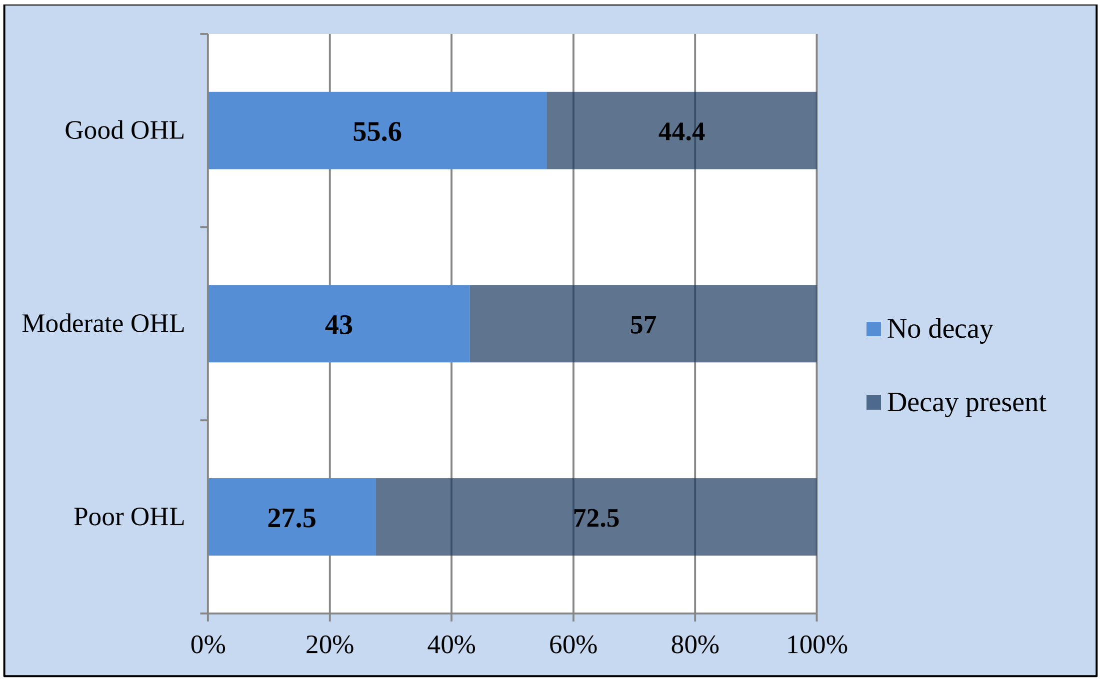

Figure 21: Association between Oral Health Literacy and Prevalence of Dental Caries

4.7.2 Bivariate Analysis

The results of descriptive analysis were confirmed using the Pearson's correlation test. Table 45 indicates that Pearson's correlation coefficient is negatively correlated with a significant p value (ρ=-.207, p < 0.001). The result indicates that DMFT scores decrease with an increase in overall oral health literacy score and vice versa, as would be expected.

Table 45: Pearson Correlation for Oral Health Literacy and DMFT Scores

		DMFT	Oral Health Literacy- Total Score
DMFT score	Pearson Correlation	1	-.207
	Sig.		.000*
	N	974	974
OHL-Total Score	Pearson Correlation	-.207	1
	Sig.	.000*	
	N	974	974

Key: *= p<0.001

4.7.3 Multivariable analysis

A multivariable regression analysis was performed with DMFT as the dependent variable and all sociodemographic and oral health literacy scores as predictor variables. In the regression performed for DMFT (Table 31; Page158) and oral health literacy scores (Table 42; Page 190), only the significant variables from preliminary analysis were entered in the model, but for this model (see Table 46, 47 & 48) every socioeconomic variable was entered in the first model. The model rendered gender (β= -.606; p<0.001), scheduled cast/tribes (β= .602; p<0.001), and oral health literacy (β= -.065; p<0.001) as predictors of DMFT with highly significant beta coefficients. The result indicates that the major predictors of DMFT are age, gender, type of school and oral health literacy. Even though the R square (.106) value is relatively low, explaining 10.6% of the variance in the dependent variable (DMFT score), there was a significant F statistic (F=6.265; p<0.001).

Table 46: Model Fitness for Multiple Linear Regression analysis of DMFT with Sociodemographic Variables and OHL Scores

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.325[a]	.106	.089	2.217

Table 47: ANOVA Results for DMFT with Sociodemographic Variables and OHL Scores

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	554.268	18	30.793	6.265	**.000**
	Residual	4694.089	955	4.915		
	Total	5248.357	973			

Table 48: Regression Analysis of DMFT with Sociodemographic Variable

	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	4.353	.559		7.790	**.000****
Gender (Male-1, Female-0)	-.606	.147	-.130	-4.121	**.000****
School Location (Rural 1; urban 0)	.115	.158	.025	.730	.465
Type of School (Public-1; private-0)	.345	.185	.074	1.865	.061
Oral Health Literacy- Total Score	-.065	.013	-.161	-4.887	**.000****
Age					
12 years	-.736	.483	-.048	-1.525	.128
13 years	-.277	.187	-.050	-1.483	.138
14 years	Reference Category				
15 years	.198	.190	.034	1.041	.298
Father's Education					
8th	-.266	.277	-.050	-.960	.337
10th	-.162	.267	-.030	-.605	.545
12th	Reference Category				
University	-.160	.292	-.031	-.548	.584
No father	.437	.476	.034	.916	.360
Don't Know	-.249	.368	-.028	-.677	.498
Mother's Education					
8th	Reference Category				
10th	-.162	.219	-.027	-.737	.461
12th	-.384	.258	-.056	-1.487	.137
university	-.426	.291	-.076	-1.462	.144
No Mother	.000	.636	.000	.000	1.000
Don't Know	-.107	.281	-.014	-.383	.702
Caste					
FC	.426	.321	.044	1.326	.185
BC	Reference Category				
MBC	.332	.197	.058	1.686	.092
SC/ST	.602	.180	.116	3.336	**.001***

Key: * = p<0.05;**=p<0.001

4.7.3.1 Regression equation

A second model was performed (Table 49, 50 & 51) to derive the regression equation with the more absolute beta value. The multiple linear regression analysis was performed by using only the significant predictors in the first model. The predictors used in the second model were caste, gender, and oral health literacy scores. The reduced model was used to build the regression equation for the DMFT predictors.

DMFT= 4.454 - .622 Gender - .074 Oral health literacy score + .450 MBC caste + .704 SC/ST

The regression equation indicates that the community Scheduled Caste/Tribes and Most Backward Caste have a positive relationship with DMFT which suggests that being in this community increases the chance of getting dental caries. The negative beta coefficient for oral health literacy indicates that DMFT increases with a decrease in the oral health literacy score. The significant beta coefficient for gender indicates that DMFT is predicted by gender in the Tamil Nadu adolescent population.

Table 49: Model 2: Model Fitness for Regression Analysis of DMFT with Sociodemographic variables and Oral Health Literacy Scores

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
2	.283[a]	.080	.075	2.233

a. Predictors: (Constant), Caste, Gender, and oral health literacy scores

Table 50: Model 2: ANOVA Results for DMFT with Sociodemographic Variables and Oral Health Literacy Scores

Model		Sum of Squares	df	Mean Square	F	Sig.
	Regression	420.366	5	84.07	16.856	**.000**
2	Residual	4827.991	968	4.99		
	Total	5248.357	973			

Table 51: Model 2: Regression Analysis of DMFT with Sociodemographic Variables and Oral Health Literacy

	Unstandardized Coefficients		t	Sig.
	B	Std. Error		
(Constant)	4.454	.451	9.878	**.000***
Gender (Male-1; Female 0)	-.622	.145	-4.292	**.000***
Oral Health Literacy- Total Score	-.074	.013	-5.728	**.000***
Caste FC	.123	.308	.399	.690
BC	Reference Category			
MBC	.450	.191	2.354	**.019***
SC/ST	.704	.177	3.975	**.000***

Key: *=p<0.001

4.8 Further Analysis with oral health literacy and DMFT scores

4.8.1 Multivariable analysis of individual components of oral health literacy and DMFT

A multiple linear regression analysis was performed to understand the predictors of DMFT scores among the components of oral health literacy namely, oral health knowledge, oral health behaviour, self-managing skills, oral health attitude and comprehension skills (See Table 53, 54 &55). A multiple linear regression was performed with DMFT as a dependent variable and forcing all components entered into the analysis at the same time. The R square value for the resultant model was .085, with a significant F statistic (F=17.956; p<0.001).

The results indicated that having a basic oral health knowledge (β= -.051; p<0.05), self-managing skills (β= -.360; p<0.005) and good oral health attitude (β= -.116; p<0.05) were predictors of the severity of dental caries. The negative beta coefficient values indicate that an increase in the individual components score decreased the DMFT score.

DMFT= 5.043 - .051 Oral health knowledge - .360 Self-managing skill - .116 Oral health attitude

Table 52: Model Fitness: Regression Analysis for DMFT and Individual Components of Oral Health Literacy

R	R Square	Adjusted R Square	Std. Error of the Estimate
.291[a]	.085	.080	2.227

Table 53: ANOVA results: Regression Analysis for DMFT and Individual Components of Oral Health Literacy

	Sum of Squares	df	Mean Square	F	Sig.
Regression	445.460	5	89.092	17.956	.000[b]
Residual	4802.897	968	4.962		
Total	5248.357	973			

a. Dependent Variable: SMEAN (DMFT)

b. Predictors: (Constant), Comprehension score, total self-management score, total behaviour score, total knowledge score, total attitude score

Table 54: Regression Analysis for DMFT and Individual Components of Oral Health Literacy

	Unstandardized Coefficients		t	Sig.
	B	Std. Error		
(Constant)	5.043	.573	8.803	.000**
Total Knowledge score	-.051	.020	-2.557	.011*
Total Behaviour score	-.080	.054	-1.470	.142
Total Self-management score	-.360	.045	-7.985	.000**
Total Attitude score	-.116	.045	-2.559	.011*
Comprehension score	-.018	.033	-.547	.585

Key: * = $p<0.05$;** = $p<0.001$

4.8.2 Effect of Caste and Gender with respect to Location of School

The Table 55 and figure 22 indicates the mean score differences between rural and urban school students with respect to gender and caste. The gender and caste are the two sociodemographic variables which had a significant association with both DMFT and OHL scores and further analysis was undertaken to learn the effect of gender and caste on oral health literacy scores and DMFT scores when adolescents live in a rural or urban environment. Table 55 indicates that mean DMFT scores for female participants are high in urban schools when compared to male participants, but the scores are almost the same for male and female participants in rural schools. The mean plot shows a steep decrease in OHL scores between urban and rural schools with an increase in DMFT scores between urban and rural school participants. Even though female participants in urban areas scored higher in OHL, the DMFT score was higher for females in both urban and rural schools.

The association between OHL and DMFT in the previous section indicated a negative relationship and every analysis indicated that DMFT decreased with increasing OHL scores and results were confirmed by the regression analysis. However, splitting the sample based on gender rendered a lack of association between DMFT and OHL scores. The result indicates that some factor other than the components (oral health knowledge, behaviour, attitudes, self-managing skills and comprehension) of OHL in the current study. For example, it might be a culturally induced attitude among parents to feed the male child of the family with the best nutritious food. This result will be discussed further in the next chapter.

The caste categories indicated a decrease in OHL scores between Forward Caste and Scheduled Caste. The DMFT score for the Backward Caste was lower in both urban and rural schools. The urban school participants who belonged to the Forward Caste scored outstandingly higher in oral health literacy, but the effect was not reflected in the DMFT scores due to the nature of the vegetarian diet habit among the Forward Caste. The participants belonging to the Scheduled Caste scored lower in oral health literacy skills and higher in DMFT both in urban and rural schools.

The results for DMFT among the female gender and OHL scores of the Forward Caste in the urban schools indicated the influence of diet in preventing dental caries and these results will further elaborated in the next chapter.

Table 55: DMFT and OHL Scores in Urban and Rural Schools for Gender and Caste Variables

	Urban			Rural			Total sample		
	n	Mean	SD	n	Mean	SD	n	mean	SD
DMFT									
Male	271	1.68	2.12	271	1.85	2.13	542	1.76	2.12
Female	187	2.09	2.30	245	2.63	2.56	432	2.39	2.50
Forward	45	1.44	1.93	15	2.47	2.82	60	1.70	2.21
Backward	199	1.60	2.08	244	1.69	2.04	443	1.65	2.06
Most backward	106	2.23	2.60	92	2.14	2.43	198	2.19	2.52
Scheduled Caste	108	2.07	2.22	165	3.02	2.54	273	2.64	2.46
Oral Health Literacy Score									
Male	271	31.22	5.92	187	31.90	5.69	542	31.89	5.93
Female	271	33.87	6.09	245	31.87	5.23	432	32.36	5.57
Forward	45	36.04	5.78	15	31.30	6.34	60	34.85	6.22
Backward	199	33.50	5.45	244	32.64	5.34	443	33.03	5.40
Most backward	106	31.69	6.57	92	32.72	4.4	198	32.17	5.68
Scheduled Caste	108	30.84	5.36	165	29.33	5.77	273	29.93	5.65

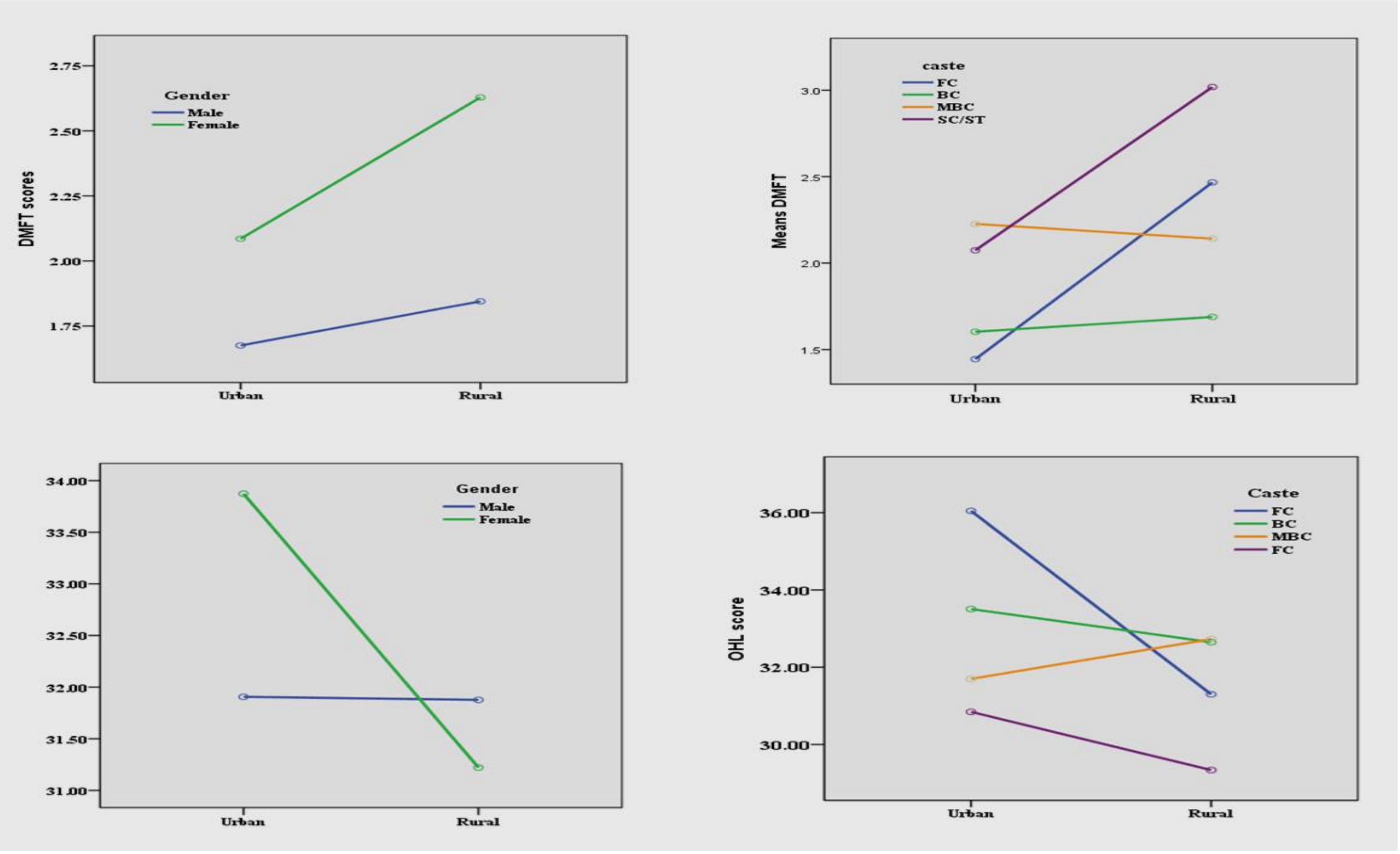

Figure 22: Means Plots for Differences in Rural and Urban Schools for Gender and Caste

4.8.3 Effect of Caste and Gender with respect to Type of School

The mean scores between private and public schools indicated that the severity of dental caries was high for public school students when compared to private school students for both genders (Figure 23 and Table 56). The differences in the DMFT scores between female and male participants were less than the differences between rural and urban schools. The oral health literacy scores for female and male participants in public schools were almost the same. Even though female participants scored higher OHL skills, both in private and public schools, the DMFT score was higher for female participants irrespective of the type of school they went and this result was not expected.

The Forward Caste participants scored higher DMFT scores (3.25) of all castes in the public school sample. The scores for Forward Caste were higher than Scheduled Caste/Tribes even though “SC/ST” was rendered as a predictor of DMFT in the previous section. The OHL scores of Forward Caste participants were dramatically higher in the private school sample which would be the reason behind lower DMFT scores in private school participants irrespective of their vegetarian diet. The scheduled caste participants scored almost the same DMFT and OHL scores in both private and public schools. The oral health literacy skills for Scheduled Caste and Tribes are lower when compared to other caste categories studying in the private schools. This result indicates that Scheduled Caste and Tribes tended to have more dental caries irrespective of their economic status.

These results indicated that being a female student in a rural and public schools increases the severity of dental caries and belonging to the community SC/ST increases the chance of getting dental caries unrelated to where one they lives and to which school one they goes. This result is further analysed in the next section using multiple variable regression analysis by creating interaction variables for type of school and location of school with respect to gender and caste.

Table 56: Effect of Type of School with Respect to Gender and Caste

	Private			Public			Total sample		
	n	Mean	SD	n	Mean	SD	n	mean	SD
DMFT									
Male	297	1.58	1.99	245	1.98	2.27	542	1.76	2.12
Female	212	1.85	2.29	220	2.91	2.58	432	2.39	2.50
Forward	52	1.46	2.05	8	3.25	2.71	60	1.70	2.21
Backward	276	1.55	2.02	167	1.82	2.11	443	1.65	2.06
Most backward	68	1.29	1.86	130	2.65	2.69	198	2.19	2.52
Scheduled caste	113	2.41	2.40	160	2.81	2.50	273	2.64	2.46
Oral Health Literacy									
Male	297	32.52	5.71	245	31.12	6.42	509	31.89	6.03
Female	212	33.58	5.04	220	31.19	5.60	465	32.36	5.31
Forward	52	35.62	6.11	8	29.90	4.74	60	34.85	6.22
Backward	276	33.56	5.61	167	32.15	4.93	443	33.03	5.40
Most backward	68	33.45	6.36	130	31.50	5.20	198	32.17	5.68
Scheduled caste	113	29.99	5.79	160	29.89	5.57	273	29.93	5.65

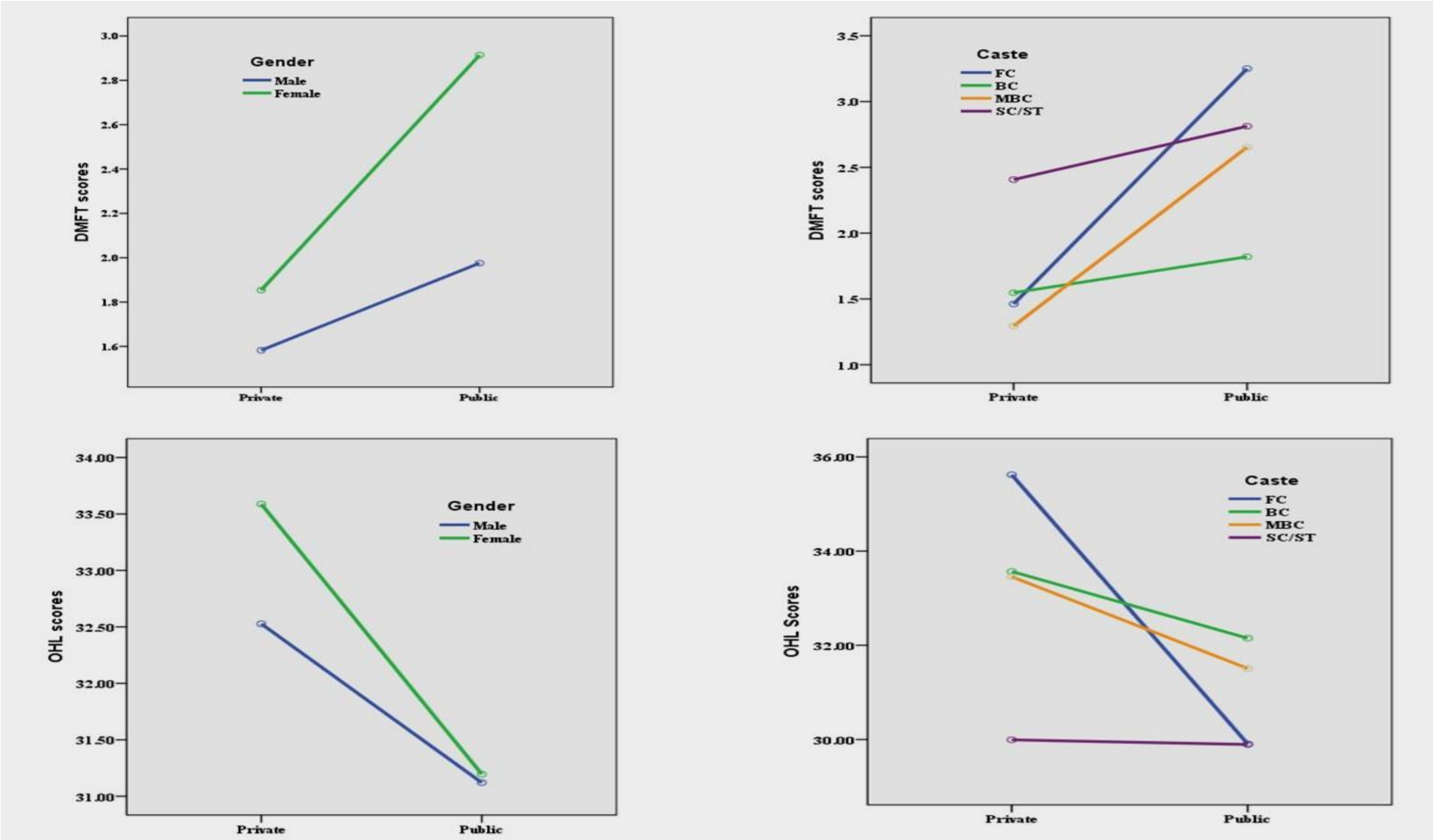

Figure 23: Means Plots for Gender and Caste Based on Type of School

4.8.4 Multivariable Regression with Interaction Effect for Gender and Caste

The descriptive analysis indicates that female gender and Scheduled Caste/Tribes community have a greater effect on the severity of dental caries than the other variables in the analysis. To understand further the effect of caste and gender with respect to type and location of school, a new regression model was performed by creating new interaction variables with caste categories and gender with rural-urban and private-public information. The multi-variable linear regression was performed with every socio demographic variable as predictors with added variables, namely, rural-male, rural-FC, rural-BC, rural-MBC, rural-SC/ST, public-male, public-FC, public-BC, public-MBC and public-SC/ST. Separate variables for urban and private schools were not needed because private-public and rural-urban variables are binary variables coded as '0' and '1'and the results based on interactions for rural (1) also give us the information about urban (0).

Usually, the category with the maximum number of participants is used as a reference category for performing regression. All dummy variables were forced into the final regression analysis.

Preliminary analyses were carried out using linear regression with each variable in turn. These all showed a significance relationship for all predictor variables. Hence, every predictor variable was included in the model at the same time rather than using stepwise regression methods (Field & Miles, 2010). All independent variables were entered into the equation in one step which is called the "forced entry approach" (Field & Miles, 2010).

The F ratio for the developed models was highly significant (OHL: F= 6.740; $p<0.001$) and (DMFT: F=4.068; $p<0.001$) with the strength of the relationship 15.5% and 10.3%, respectively. Even though the R square value is low for each model (DMFT: R^2=0.104 & OHL: R^2=0.161), the highly significant F statistics (see Table 57) indicates that an actual relationship between the significant predictors and dependent variable is present. As previously described in this chapter, a regression model with little variability and low R-square value would be still a meaningful result, if the F value is significant.

The first model in Table 57 is performed with the dependent variable as DMFT and sociodemographic variables and all interaction variables for type of school and location of school.

The model is rendered with Scheduled Caste/Tribes with respect to location (β=.721; $p<0.05$), gender by the type of school (β=-.558; $p<0.05$) and the Most Backward community participants in public schools (β=.190; $p<0.05$) as significant predictors for DMFT.

The results indicate that the DMFT mean scores differ based on the location of school for different gender. Rural schools and male gender were used to make the interaction variable. Hence, the negative beta coefficient for rural- gender indicates that male participants in rural schools had healthier teeth than female participants when compared to urban counterparts.

The participants from the community Scheduled Caste and Tribes living in rural areas are more affected by dental caries when compared to urban counterparts, but the scores are unchanged and not affected by the type of school they go to.

The participants from the Most Backward community, if they studied in public schools, were more affected by dental caries when compared to private school participants.

Table 57: ANOVA and R-Square for the Regression Analysis with Interaction for Caste and Gender within Type and Location of School

	DMFT	OHL
ANOVA	F=4.068; p=0.000	F=6.740; p=0.000
R-Square	.104	.161
Adjusted R square	.078	.137

Table 58: Regression Analysis with Interaction for Caste and Gender within Type and Location of School

	DMFT				OHL			
	Unstandardized Coefficients		t	Sig.	Unstandardized Coefficients		t	Sig.
	B	Std. Error			B	Std. Error		
(Constant)	2.216	.377	5.877	.000	34.472	.907	38.015	.000
Gender (M)	-.258	.257	-1.005	.315	-2.045	.617	-3.315	**.001***
Age								
12 years	-.816	.487	-1.675	.094	-.275	1.172	-.235	.814
13 years	-.194	.188	-1.030	.303	-1.292	.452	-2.855	**.004***
14 years	Reference category							
15 years	.208	.191	1.089	.277	-.569	.460	-1.238	.216
Father's education								
8th	-.192	.278	-.689	.491	-1.260	.669	-1.883	.060
10th	-.148	.269	-.552	.581	.008	.646	.013	.990
12^{th}	Reference category							
University	-.211	.294	-.719	.472	1.176	.707	1.664	.096
No father	.489	.481	1.018	.309	-1.655	1.155	-1.432	.152
Don't Know	-.057	.371	-.154	.878	-1.676	.891	-1.881	.060
Mother's Education								
8^{th}	Reference category							
10^{th}	-.193	.222	-.870	.385	.192	.534	.360	.719
12^{th}	-.437	.261	-1.671	.095	.373	.629	.594	.553
University	-.538	.294	-1.828	.068	1.563	.708	2.207	**.028***
No mother	-.087	.645	-.136	.892	-.067	1.550	-.043	.965
Don't Know	-.189	.285	-.664	.507	-.043	.686	-.063	.949
Caste-Total Sample								
Forward caste	-.083	.409	-.203	.839	1.663	.983	1.693	.091
BC	Reference category							
MBC	-.037	.349	-.105	.916	-.844	.839	-1.007	.314
Caste SC/ST	.284	.333	.852	.395	-2.692	.802	-3.359	**.001***
School								
Rural-Urban	-.011	.283	-.038	.970	-1.790	.681	-2.629	**.009***
Public-Private	.374	.302	1.236	.217	-.184	.727	-.253	.801
Rural-Urban school Interaction with Gender and Caste								
Rural Male	-.055	.297	-.184	.854	2.191	.714	3.067	**.002***
Rural FC	.788	.703	1.121	.262	-3.305	1.690	-1.955	.051
Rural BC	Reference category							
Rural MBC	-.581	.391	-1.487	.137	2.283	.939	2.430	**.015***
Rural SC/ST	.721	.353	2.042	**.041***	-.464	.849	-.547	.584
Public- Private school Interaction with Gender and Caste								
Public Male	-.558	.294	-1.896	**.051***	.428	.708	.605	.546
Public FC	1.267	.889	1.426	.154	-3.308	2.137	-1.548	.122
Public BC	Reference category							
Public MBC	1.118	.407	2.745	**.006***	-.744	.980	-.760	.448
Public SC/ST	.190	.358	.530	.596	.837	.862	.971	.332

Key: * = p<0.05

The second model in the table was the results of linear regression for OHL score and sociodemographic variables and the interaction variables for type and location of school. The results indicates that the predictors of oral health literacy are gender ($\beta=-2.045$, $p<0.05$), mother's education at university level ($\beta=1.563$, $p<0.05$) and being a Scheduled Caste or Tribes (-2.692, $p<0.05$) for the overall sample.

Also rural gender ($F=2.191$; $P< 0.005$), rural Forward Caste ($F=- 3.305$; $p<0.05$), rural most Backward Caste ($F=2.283$; $p<0.05$), are significant predictors of OHL when the sample was split into rural and urban populations. The result implies that the oral health literacy skills difference between females and males was affected by the location of the school. The oral health literacy of Forward Caste participants and Most Backward Caste participants was affected by the location of the school but Scheduled Caste or Tribe participants' OHL skills does not depends on where their school is located.

The differences in OHL scores for caste and gender were unaffected when controlling for type of school.

The result indicates that caste and gender have a major role in predicting oral health literacy in rural locations of India when compared to urban locations. In conclusion, differences in the mean DMFT and OHL scores between gender and caste categories have an impact based on the location of schools but not by type of school. The Scheduled Caste or Tribe participants DMFT scores were unaffected by the type and location of the school they attend.

4.9 Key Findings

The summary of the key findings will be given under three sub topics with the research question as a sub title. Later, the key findings will be analysed, clustered and presented with respect to different socioeconomic variables namely, gender, age, parents' education, caste and school.

4.9.1 Key Findings: Research Question 1

What is the prevalence and severity of dental caries in Tamil Nadu adolescents?
Prevalence of Dental Caries
61.4% of the total sample had dental caries.
Prevalence was higher in females compared to males.
Parents’ education was negatively associated with caries prevalence, that is, the higher the parents’ educational level the lower the dental caries demonstrated in the adolescents
Caste had a great impact on dental caries prevalence with SC/STs castes having a higher prevalence and severity of dental caries compared to other castes.
Dental caries increased with age, with 15 year old students having more dental caries compared to 12 year old students.
Rural and public school participants were more affected, that is rural school students had a higher prevalence of dental caries compared to urban school students, and public school students had a higher prevalence of dental caries compared to private school students.
The predictors of the prevalence of dental caries were identified using logistic regression and the model rendered type of school (public) and being in the Scheduled Caste and Tribes (SC/ST) community as significant predictors of dental caries.
DMFT-Severity of Dental Caries
Mean DMFT score was 2.03.
DMFT females=2.39; Male=1.76 ; $t=-4.76;p<0.05$
Adolescents with no father or mother had higher DMFT than adolescents from other categories
Scheduled Caste and Tribes had very high DMFT (2.64) score.
Rural schools (1.70) and public schools (2.64) had higher DMFT scores
Multiple linear regression rendered gender, age, mother’s education and caste as significant predictors of dental caries.
Further Important Findings
In total, 1980 teeth were affected and 98.6% (1953) were decayed. A low number of teeth were filled (21).
Almost 91% of participants reported that they never been to a dentist. 4.1% of participants went to a dentist for extraction of decayed deciduous teeth. 2.1% of participants had been to seek advice on orthodontic treatment but only 0.5% reported they been to a dentist for a routine dental check-up.

4.9.2 Key Findings: Research Question 2

2. What is the level of oral health literacy among adolescent in rural and urban areas of Tamil Nadu?
Components of Oral Health Literacy
Up to 90% of the sample used tooth paste and a brush. Only 4% of participants used floss. Twelve percent of participants did not have access to fresh fruits. Fifty seven percent of participants had sugary snacks every day.
Public school students scored higher in the behaviour scores (8.14).
Private school students scored high in knowledge (6.05), attitude (8.35) and comprehension (7.75) components compared to public school students.
Urban school students scored higher in knowledge and comprehension compared to rural school students but scores for the behaviour and attitude components were higher for rural school students.
Oral Health Literacy (OHL-raw score)
Parents' education was highly negatively correlated with adolescents' OHL. That is, the higher the parents' educational level the lower the OHL scores. The mother's education had a higher impact compared to the father's education.
Rural (31.50) and public school (31.15) participants scored lower than urban (32.70) and private (32.96) school participants respectively on OHL. The results are statistically significant for these comparisons.
Females (32.36) scored higher than male (31.89) participants on the OHL with statistically significant results both in bivariate and multiple-variable analyses.
Scheduled Caste and Tribes community scored less (29.45) on OHL among all participants and the mean score difference is statistically significant.
Parents' education, gender and caste were identified as significant predictors of OHL in the regression analysis.
Further Analysis: OHL (category)
In total, 35% of participants had poor OHL to prevent dental caries and only 8.3% of participants had good OHL skills to prevent dental caries.
Except age, all sociodemographic variables were significantly associated with OHL categories in bivariate Chi-square analysis.

4.9.3 Key Findings: Research Question 3

3. What is the association between oral health status and oral health literacy in adolescents?
Prevalence of dental caries was higher in adolescents with poor OHL skills.
DMFT score of '0' was associated with moderate and good OHL.
Pearson correlation coefficient indicated that raw OHL scores were statistically associated with DMFT scores. The negative correlation indicated that an increase in oral health literacy score decreased the DMFT average.
Regression analysis with DMFT and individual components of OHL indicated that oral health knowledge, attitude and self-managing skills are significant predictors of DMFT.
Oral health behaviour and comprehensive knowledge did not predict DMFT in the study sample.
Multiple linear regressions indicated that OHL scores are a predictor of DMFT after controlling for all sociodemographic variables.
When compared to private and urban schools or, going to a rural school and/or a public school, an adolescent's caste and gender had a greater impact on predicting oral health status and oral health literacy than the other variables used in the analysis.

4.9.4 Cluster analysis of key findings

Gender
Females had higher carries prevalence as well as DMFT scores and the results were statistically significant
Males scored slightly lower than females in OHL with results being statistically significant.
Females scored higher in the oral health behaviour component but behaviour was not rendered as a predictor of dental caries.
Males scored higher than females only in the comprehensive component of OHL
Both DMFT and OHL were predicted by gender but the prevalence of dental caries was not predicted by gender.
Age

Age was associated with DMFT scores and OHL scores but age was not confirmed as a predictor of DMFT or OHL in the regression analysis.
Decay prevalence was higher among 14 year-olds and DMFT score was highest for 15 year olds among all age group.
The OHL score was higher for 14 year olds than 15 year olds when controlling for type of school, location of school and caste.
The behaviour score was higher among 12 year-olds compared to other age groups. With an increase in age the behaviour score decreased.
Caste
Scheduled Caste and Tribes had poor OHL skills and higher caries prevalence compared to other communities.
Forward Caste participants had less overall decay prevalence when compared to the Backward Caste but the severity of dental caries was higher in the Forward Caste when compared to the Backward Caste. Adolescents from the Forward Caste scored higher in oral health literacy when compared to all other castes. These results were statistically significant.
Caste was rendered a major predictor of DMFT and OHL even after controlling for type of school, location of school and gender.
Parent’s Education
Participants who did not know their father’s or mother’s education had more decay and scored less in OHL.
Participants without a father or mother had poor oral health status and also poor oral health literacy skills.
The father’s education at university level had an impact on an adolescent’s oral health or OHL but the mother’s education at 10th standard and above had improved an adolescent’s oral health as well as oral health literacy. Only the mother’s education was rendered as a predictor in regression analysis for both DMFT and OHL.
Schools
Prevalence of dental caries was higher in rural and public school participants.
DMFT was higher among public and rural school participants.
OHL was higher among private and urban school participants.
Oral health behaviour and attitude score were higher among rural students when compared to urban participants.
In individual OHL components, privates school students scored higher than public school students

Chapter 5: Discussion

5.1 Introduction

This chapter discusses the thesis results. The thesis project aimed to measue the prevalence of dental caries, the severity of dental caries, and the level of oral health literacy skills among adolescents in rural and urban parts of the Indian state of Tamil Nadu. It was hypothesised that there was a clinically meaningful relationship between the prevalence and severity of dental caries and oral health literacy among adolescents living in Tamil Nadu. The results identified the prevalence percentage of dental caries, severity of dental caries and the level of oral health literacy skills among adolescent school students in Tamil Nadu state with respect to gender, location of school, type of school, and among different community/caste categories. This study is the first to examine all these factors and bring them together into a single analytical framework. The results are discussed for each research question in three sections with the research questions as a title. For each research question, first, the relevant key results are briefly presented. Second, the key results are interpreted followed by comparison of the research results reported in the literature. The implications of the results and how they can be more applied generally are also given.

5.2 Population Profiles

In total, 974 adolescents from rural and urban schools in Tamil Nadu were recruited. The calculated sample size had been 800 adolescents but 974 participants were recruited because it was proposed to involve every student in the selected class within each school. It was anticipated that majority of adolescents from disadvantaged background would have not had visited a dentist and therefore random selection within each class was deliberately avoided. The same type of selection method was used in Sarvanan et al.’s study (2008) and the authors indicated that every child in the class was selected to avoid embarrassment among children and parents. Apart from issues of equity for the students the number of participants recruited meant that the study met the power analysis and sample size requirements.

Although the intention had been to recruit from eight schools, most of the urban schools, (i.e. those in Chennai), did not give permission to recruit participants for the oral health survey and hence, the participants were recruited from only four schools. This is a limitation of the study which is discussed in the next chapter.

In the study sample, males (55.6%) were slightly over-represented when compared to overall Tamil Nadu male population (50.1%) but this is unlikely to limit external validity of the study results in regards to gender explanations because the difference is small. This difference had been expected as the gross school enrolment percentage for females is low for secondary school attendance. Generally, the gross enrolment ratio (GER) for females is lower because of higher drop out ratio after the primary level. The lower socioeconomic population do not send female children to school but retain them at home to do house hold chores or else to earn money. Jeyalakshmi et al. (2012) report that, female gross enrolment (74.1%) is less than males (81.5%) in Tamil Nadu schools. This is in contrast to the 100% GER for primary (age 5-10) and upper primary (age 11-13) that Ashokam industrial body (2013) report. This places Tamil Nadu as ranking first in the whole country for primary school enrolment. These reports suggest that the female drop out ratio is becoming higher in secondary school (age 14-15) and higher secondary level (age 16-17). Even though the GER for 11-13 years in Tamil Nadu is 100%, the decrease in female GERs in secondary level (14-15) caused the slight over representation of male participants in the current thesis research. In the current research, number of 14 year olds in the sample was highly represented which caused the overrepresentation of male participants.

Fifty-four 12 and 13 year olds' data were removed from the analysis because of un-erupted permanent teeth. Most of the schools did not give permission to recruit participants from 10th (15 year olds) standard on the grounds of their busy academic schedule and this therefore decreased the number of 15 year olds in the sample. Hence, 14 year olds were over represented in the sample.

The parents' education level of study participants was as expected. The father's level of education was higher when compared to the mother's level of education. The majority of the participants' fathers had completed university education (28.1%). The majority of the participants' mothers (34.5%) had only completed school education at or below the 8th standard (13 years), which contrasts with only 26.5% of participants' fathers with that level of education. This is unsurprising given that the overall Tamil Nadu population literacy rate for males is higher (86.8%) when compared to females (73.9%).

The results indicated that community/caste percentages reported in the study closely matched Tamil Nadu's total population. The caste category Scheduled Caste and Tribes (SC/ST) (28%) was slightly overrepresented when compared to overall Tamil Nadu Scheduled Caste and Tribes (SC/ST) population (20%). Even though the SC/ST gross enrolment is relatively lower (26.8%) compared to other communities in Tamil Nadu, in the study sample, the SC/ST participants were over-represented because half of the study sample was recruited from the public schools where the majority of the Scheduled Caste and Tribes population attend to access the advantage of subsidies under the free mid-day meal policy. Another reason for an overrepresentation by Scheduled Caste and Tribes was that half of the study sample was selected from Chennai, an urban area where the literacy rate and gross enrolment rates of SC/ST are higher than all other districts of Tamil Nadu. Chennai also has the lowest percentage drop-out rate at secondary level for Scheduled Caste and Tribes (16.5%) whereas the national average for Scheduled Caste and Tribes is 23.5% (Tamil Nadu Social Development Report, 2000).

5.3 Research Question 1

What is the prevalence of dental caries and the severity of dental caries in adolescents in Tamil Nadu schools?

There has been remarkable progress in the reduction of dental caries in developed countries over the past 30 years. Simultaneously, the prevalence of dental caries is increasing in developing countries, such as India, because of growth in the economy and changes in dietary habits. Several epidemiological studies have been conducted on dental caries and dental treatment needs in different parts of the world. In developing countries like India, preventing dental caries is in the beginning stages of implementation. In India, the prevalence of dental caries ranges between 31% and 89% (Grewal, Verma, & Kumar, 2009). The WHO conducted a multi-centric study comparing oral healthcare needs in different states of India but the state of Tamil Nadu was not included in that study (Shah et al., 2007). There have been a number of studies conducted in different districts of Tamil nadu but for the adolescent population of age 12-15 years, baseline data for both the rural and urban population were not available, nor were the data to understand distribution of dental caries between different caste categories available. It is for this reason that the current thesis was undertaken to meet this evidence base gap in knowledge. In the current thesis, prevalence and severity of dental caries were measured in 974 rural and urban, 12-15 year-old, school children, using the WHO oral health assessment form, designed by WHO oral health programme, Geneva (2004). Prevalence and severity of dental caries were measured and the results are discussed below in two separate sections.

5.3.1 Prevalence of Dental Caries

5.3.1.1 Interpretation of results

The prevalence of dental caries was 61.4%, and the prevalence rate was higher among female participants when compared to male participants. The parents' level of education was negatively associated with the prevalence of dental caries with the results being statistically significant. Dental caries increases with age because of untreated decay. The rural and public school participants were more affected, and exhibited more untreated decay on clinical examination, when compared to urban and private school participants respectively. In regression analyses, the type of school and caste were identified as the major predictors of dental caries in the adolescent school population of Tamil Nadu.

5.3.1.2 Comparison of results with international literature

A recent report from the World Dental Federation (2014) indicates that almost 100% of adults and 60% - 90% of school students are affected by dental caries. The table 59 indicates the prevalence of dental caries for different countries and the current study. Compared to other countries, the prevalence of dental caries is higher in the current study (See Table 59). The prevalence of dental caries in the Philippines and Armenia were reported as being higher than in India. The prevalence of dental caries is well controlled in countries such as Australia and New Zealand through public oral health services and also by community water fluoridation. In India, the prevalence of dental caries is increasing and publicly funded oral health services are available for less than 5% of population. This indicates that both an urgent oral health literacy intervention as well as publicly funded oral health services are required for everyone living in Tamil Nadu. The recommendations for improving oral health literacy are presented in the next chapter.

Table 59: Prevalence Percentage in the Current Study and Other International Studies

Country	Reference	Year	Age	Prevalence%	Male %	Female %
United States	Leverett (1982)	1999-2004	12-15	50.67	55.66	62.74
Australia	Mejia and Ha (2011)	2009	12	36.6	40	44
Australia		2009	15-24	63.5		
New Zealand	Bagramian et al. (2009)	2009	12	49.3		
Norway	,,	2004	12	59.8		
Armenia	,,	2005	12	86		
Brazil	,,	2000	12	53.6		
Philippines	,,	2003	12	59-92		
China	,,	2003	12	60		
Current study		2012	12-15	61.4		

5.3.1.3 Comparison of results with past studies conducted in India

The studies carried out by Babu et al., (2011) and Suprabha et al., (2013) in Andra Pradesh, Tamil Nadu's neighbouring state, reported prevalence rates of 65.5% and 59.4% respectively, which are closest to the current study (See Table 60). But, when comparison is made with a range of sites all over India, the overall prevalence rate for the current study sample is higher than for 6 sites reported for 15 year old participants in the multi-centric study conducted in 2007 (see Table 60). This indicates that the dental caries prevalence rate is still higher in Tamil Nadu despite to a recent community effort in Tamil Nadu that introduced free oral health services to rural areas through Primary Health Centers.

Table 60: Prevalence of dental caries reported in 12 and 15 year olds reported in multi-centric study (Shah et al., 2007) and the Current study

Site	12 year olds	15 year olds
Arunachal Pradesh	44.4	48.5
Delhi	48.6	52.4
Maharashtra	50.4	58.5
Puducherry	71.5	83.4
Rajasthan	53.8	55.4
Orissa	23.0	24.3
Utter Pradesh	49.8	54.9
Current Study	52.2	61.9

The prevalence of dental caries is higher in the current study than 6 sites in the multi-centric study (2004) for both 12 year olds and 15 year olds (See Table 60) but less than Puducherry, a Union Territory geographically located within Tamil Nadu.

The rural oral healthcare scheme was implemented in 2008 in rural areas of Tamil Nadu by the Tamil Nadu Government under the aegis of the “National Rural Health Mission”. A free oral health community service is currently serving 360 primary health centres covering rural areas of Tamil Nadu, providing emergency treatments, scaling, filling, and extraction free to all age groups by qualified dentists (Health and Family Welfare Department, 2012). Even after a huge community effort by the Tamil Nadu Government, by means of improving access to oral health services, the prevalence of dental caries was higher than the other parts of India as reported in Multi-centric study (Shah et al., 2007). Compared to other states of India, the prevalence of dental caries is higher in Tamil Nadu. A recent study by Dhar et al., (2013) conducted in the state of Rajasthan has reported slightly lower prevalence (51.5%) than the 2007 multi-centric study (53.5%). This might be because of the rural oral healthcare scheme implemented in that state. Because the state of Tamil Nadu was not included in the 2007 multi-centric study the current results cannot be compared to that study.

5.3.1.5 Comparision of Results with past studies in Tamil Nadu

Table 61 indicates the prevalence of dental caries in different parts of Tamil Nadu from a range of studies, including the current one. Table 61 shows that the current study sample has the lowest reported prevalence rate among those reported by other authors for the Tamil Nadu region. There are two reasons for the differences in the prevalence percentage between the current study and other studies conducted in Tamil Nadu. In the comparative studies, the participants were drawn from a younger age (below 12 years) group than the current study, which included 12-15 year olds. Participants who had only permanent teeth were recruited for the current study and newly erupted permanent teeth are less affected by decay than deciduous teeth which have been exposed to the oral environment for longer time. Moses et al. (2011) reported a prevalence rate closest to the current study and of note is that it is the only study that included 15 year olds for the Tamil Nadu region.

Table 61: Prevalence percentage in Tamil Nadu Studies and the Current Study

Author	District	Location	Year	prevalence	Boys	Girls	Age
Mahesh et al.	Chennai	urban	2005	80	80.5	81.5	12
Prabhu et al.	Kanchipuram	Urban and Rural	2013	65.8		Higher	12
Sunitha et al.	Kanyakumari	Rural	2005	77	80	73	6-12
Saravanan et al.	Chidambaram	Rural	2008	70.02	78.9	65.0	9-10
Moses et al.	Chidambaram	Sub urban	2002	63.83	64.0	61.4	5-15
Current Study	Tamil Nadu	Urban and Rural	2012	61.4	58.5	65.0	12-15

When the current study results were compared to studies conducted in the Tamil Nadu region, the prevalence percentage decreased between the studies conducted in 2005 and 2013. Prabhu et al.'s (2013) study reported the prevalence rate as 65.5% for the Kanchipuram district. The current study result is in accordance with the 2013 study but not with study completed before 2005.

This considerable decrease in prevalence of dental caries might be associated with an increasing access to oral health services in rural parts of Tamil Nadu under the “National Rural Health Mission Scheme” which had some impact on adolescents’ oral health but, 91% of current study participants indicated that they have never been to a dentist. Not visiting dentist would indicate that free oral health services used by the parents had brought some impact on their children’s oral health but it did not effect an increase of visits to a dentist. This result also indicates that there is lack of oral health literacy among the adolescent population regarding oral health and dental caries to identify decay in early stage and then to seek professional help even when it is available at no cost. Despite the fact oral health services are offered for free, adolescents need basic oral health knowledge and the self-management skills to recognise dental caries at an early stage and seek help whenever needed.

Even in developed countries like New Zealand, a periodic dental check-up is undertaken for younger children at schools dental clinics. Oral health services are offered free to everyone under 18 years of age, and the adolescent population are expected to visit dentists routinely. Adolescents are considered old enough to prevent dental caries and to seek professional help when it is needed with parental help rather than by parents forcing them to attend a compulsory periodic check-up. For example, the European country, Slovakia has a policy of Governnent funded, compulsory oral examination every 6 months for all ages below 18 years and once a year for all adults. Even though it is a law to visit the dentist every year and services are provided for free, a recent report from that country indicates 34% of 0-14 years have never visited the dentist (Kravitz, Bullock, Cowpe, & Bames, 2014). This indicates that compulsory law to visit a dentist and offering free oral health services through primary health services would not be enough to prevent dental caries. It follows therefore, to make adolescents use the free services provided through PHCs, adolescents should be empowered by improving their oral health literacy which will enable them to understand the oral health consequences of attending or not attending dental examinations.

5.3.2 Severity of Dental Caries

5.3.2.1 Interpretation of Results

The severity of dental caries was measured by using the DMFT index. The average DMFT score for the sample was 2.03. The decay component contributed more to the total DMFT (1983 teeth) score with 1, decayed teeth out of total affected teeth (1980) being identified by the clinical examination. The severity and number of decayed component increased with increase in the participants' ages. The severity of dental caries was higher for female participants when compared to male participants and this difference was statistically significant and hence, gender was rendered as a predictor of dental caries severity in regression analyses. The difference in DMFT between male and female participants was higher between private and public school students but the difference is less when gender was controlled for in the rural and urban population. The females studying at public schools had more dental caries when compared to private schools and the "public school female" category was rendered as one of the predictors of severity of dental caries in multiple linear regression analysis. The location of school, be it, rural or urban schools, did not affect the severity of dental caries in females.

The severity of dental caries decreased with increase in the parents' education and, in particular, the mother's educational level was rendered as one of the predictors of severity of dental caries in multiple linear regression analysis. The severity of dental caries was higher among adolescents who reported not having one or either of their parents living with them. Except age, all sociodemographic variables had a significant association with severity of dental caries. The participants who did not know their parents' educational level had a higher number of decayed teeth than other categories but severity was higher for the adolescents who reported not having one of their parents living with them.

Even though the prevalence of dental caries was lower for Forward Caste compared to other communties, the severity of dental caries or DMFT average was lower for participants who belong to Backward Caste when compared to other categories. The severity was higher for the participants from the communities Most Backward, Scheduled Caste and Tribes. This result was significant in an ANOVA test and MBC and SC/ST were demonstrated to be predictors of dental caries severity in multiple-linear regression analysis. Scheduled Caste and Tribes living in rural schools are more affected than Scheduled Caste and Tribes living in urban areas with the results being significant in multiple linear regression analysis.

5.3.1.2 Comparison of current study DMFT with International studies

The DMFT reported in the current study was compared with DMFT average of 6 regions of WHO reported in Moriera et al.'s (2012) study. The DMFT reported in current study was lower than the DMFT reported for American and European countries (see Figure 24).

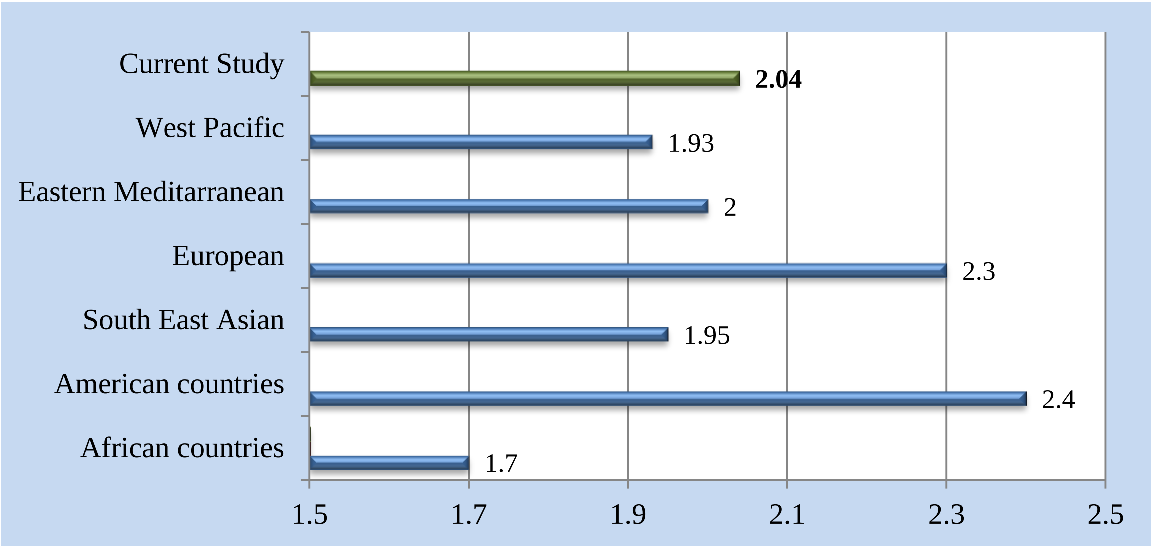

Figure 24: Comparison of DMFT Average of Current Study with Six Regions of the World

The DMFT was higher than all other WHO regions. Figure 26 indicates that the DMFT reported for South East Asian countries was 1.95 and it is increased in the current study (2.04). Even though it was considered that India had achieved the WHO target of "DMFT below 3 for 12 years olds", the DMFT average has started increasing in recent years because of changes in the country's economy, an increase in westernised food intake, and the availability of more sugar rich food.

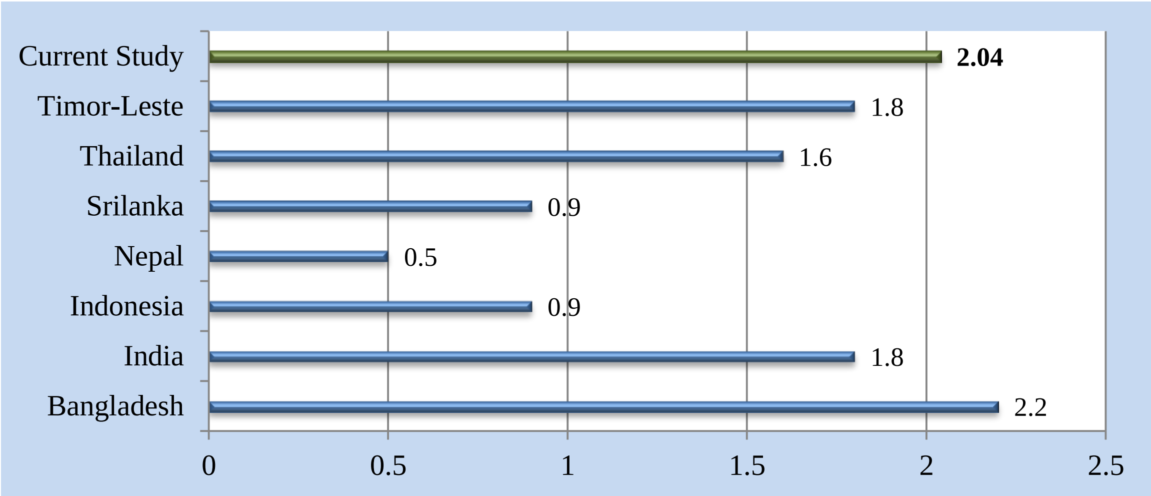

Figure 25: Comparison of DMFT Average of Current Study with South East Asian Countries

Figure 25 indicates the DMFT average for the current study and for the South East Asian countries as reported by WHO in 2002. The figure indicates that the DMFT average is higher in the current study than the DMFT reported for India in the 2002 WHO study. When compared to other countries, the DMFT reported in the current study is less than that for Bangladesh and higher than other countries (including India). This indicates that DMFT average has increased in the last five years even after introducing the rural oral health services policy through Primary Health Centres. An increase in the DMFT average was also reported in recent studies done in Indian states.

5.3.1.3 Comparison of study result with Indian studies

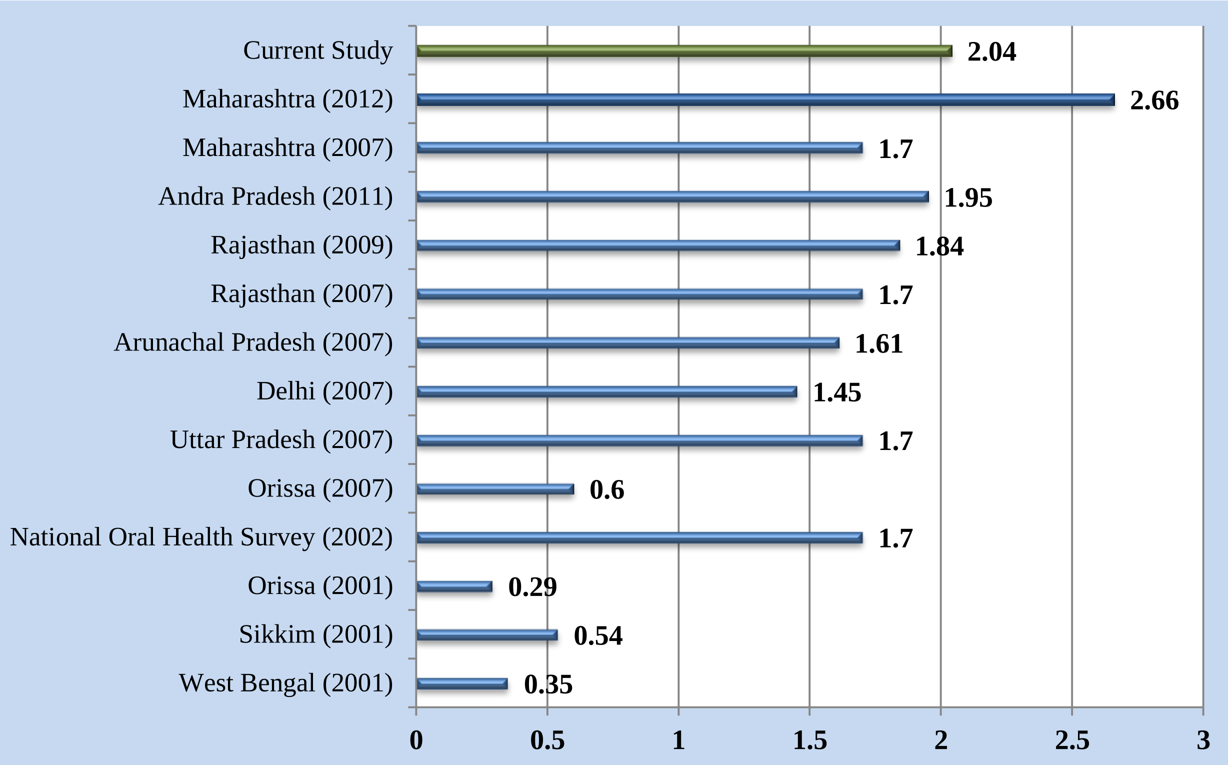

Figure 26: Comparison of DMFT Average of Current Study with Indian Studies

The comparative analysis of the DMFT average reported in other recent studies conducted in a number of different parts of India was compared with findings of the current study. Figure 28 indicates that the DMFT reported for each state increased after 2007 Multi-centric study. The DMFT reported in the current study (2.04) is second only to Maharashtra in 2012 (2.66). An increase in the DMFT throughout India is observed and this is likely because of a growing economy and lack of awareness about preventing oral health diseases while adopting an increasingly westernised diet.

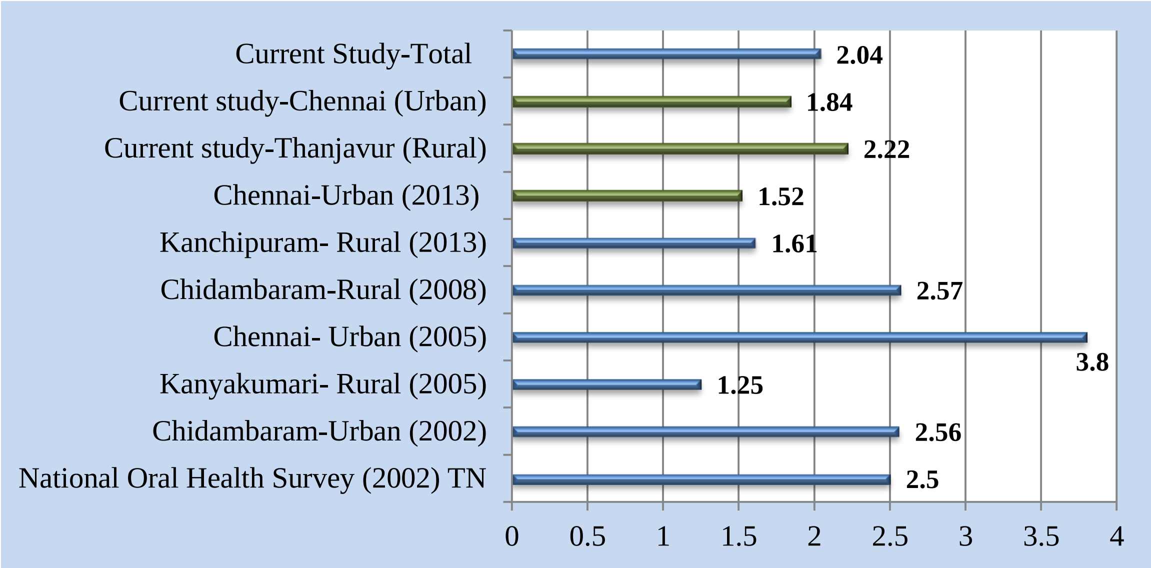

Figure 27: Comparison of DMFT Average of Current Study with Tamil Nadu Studies

An important trend was identified when comparing the current study's DMFT average with other studies conducted in Tamil Nadu state (Figure 27). The DMFT average for rural areas of Tamil Nadu is higher than urban areas and the DMFT averages for both rural and urban areas have increased between 2002 and 2012. Prabhu et al.'s (2013) study indicated a DMFT average of 1.61 for a rural area in the Kanchipuram district which is lower than the current study's rural DMFT average (2.22). The reason for the lower DMFT average for the Kanchipuram district is because this district has the advantage of oral health services both from primary health centres and also from two private dental universities which offer free oral health treatment for everyone in that area. Furthermore, two more dental universities are located within 50km of the Kanchipuram district and those are located in the Chennai district. There is no dental university situated in the Thanjavur district, where the current study's rural population was recruited from and this would likely account for the higher DMFT in Thanjavur district. Another reason for a higher DMFT for adolescents in rural areas is a lack of oral health awareness and oral health literacy; this association is discussed later in this chapter. There is a significant difference in the DMFT average between Mahesh et al.'s

(2005) study and the current study because of the difference in the age of the participant in the studies. In Mahesh et al.'s (2005) study the participants' age was 5-12 years and dental caries activity is comparatively high for this age group. This is in contrast to the 12-15 years age range for this thesis project.

In conclusion, the severity of dental caries is higher in Tamil Nadu when compared to other states of India. The studies conducted in Tamil Nadu show that the prevalence of caries decreased between 2005 and 2012 but that the severity of dental caries has increased over this time. This result suggests that oral health services available are unequal. The areas which had implemented free oral health services had also controlled the occurrence of oral disease but the areas which do not have oral health services have witnessed an increase in severity of dental caries for those who already had oral disease. In other words, those who were already affected have more decay when compared to 2005 studies but the number of adolescents affected has decreased.

5.3.3 Prevalence and Severity of Dental Caries in Different Socioeconomic Variables

The prevalence and severity of dental caries were further analysed to understand the characteristics of the vulnerable population.

5.3.3.1 Gender Disparity

The prevalence of dental caries was higher for female participants (65%) than male participants (58.5%) in the overall sample. The male participants had a lesser prevalence percentage with a statistically significant difference between the two categories. The DMFT for male participants (1.79) was lower than female participants (2.39). This difference in DMFT was statistically significant in an independent *t*-test. These results were comparable with the results reported in the studies by Prabhu et al., (2013) and Mahesh et al., of both rural and urban areas (see Table 62). Prabhu et al.'s (2013) study reported that females had more decay than male participants in both rural and urban areas but the prevalence percentage was not indicated. The Multi-Centric Survey by WHO in 2007 in India reported a higher prevalence in females when compared to male participants for 15 year olds (See Table 62) in 6 sites except in Puducherry, a French influenced Union Territory, where the GER for females is 100% and the drop out ratio for higher secondary is equal to males.

The DMFT average was higher for males in two sites which included Puducherry and Arunachal Pradesh. All other sites' results were in accordance with current study results and females had more decay when compared to males. This difference was also noticed in a recent study conducted by Dulal et al.(2013).

Table 62: Prevalence and DMFT average in the current study and Multi-centric study with Respect to Gender

	Prevalence			DMFT Average		
Site	Males	Females	Total	Males	Females	Total
Arunachal Pradesh	43.2	53.9	48.5	2.18	1.76	1.45
Delhi	50.5	54.3	52.4	1.37	1.53	1.45
Maharashtra	52.8	64.3	58.5	1.48	1.91	1.69
Puducherry	85.0	81.8	83.4	4.17	3.94	4.05
Rajasthan	55.6	55.1	55.4	1.69	1.74	1.71
Orissa	23.2	25.4	24.3	.57	.62	0.59
Utter Pradesh	53.4	56.0	54.9	1.50	1.88	1.71
Current Study	58.5	65.0	61.4	1.76	2.39	2.03

The prevalence and severity of dental caries being higher for females is not an unusual result because of the nature of tooth structure and early eruption of teeth in females (Prabhu & John, 2013). Although this result is not an unusual finding reported in either Indian or international literature (India Edunews, 2008; Ministry of Human Resource Development, 2013a), this difference needed a further investigation for the Indian context where gender discrepancies are very common. The females in rural areas have less access to nutritious food when compared to males because from a cultural perspective sons are considered more important than daughters (Ajithkrishnan et al., 2014). A study conducted among adolescent girls in rural areas indicated that thinness and stunted growth are more common in girls and reported that as a reason for nutritional disorders such as anaemia, dental caries and angular stomatitis (Dilip Das & Biswas, 2005).

A comparison was performed to understand the tendency of importance given to sons when compared to daughters. The differences in the number of fillings and dental visits between male and female participants were analysed. The number of filled teeth and dental visits were less than 10% and only a frequency analysis was performed. The frequency analysis indicated that there were more filled teeth for males (11%) and also more number of male participants (9.2%) who visited a dentist when compared to females (8.4%). The differences are really too small to provide further interpretations and implications and the available data were not insufficient to investigate this relationship further. More in-depth nutritional and parental attitudes based data will be needed to examine this phenomenon.

5.3.3.2 Parent's Literacy

A strong negative correlation was identified between the parental level of education and dental caries. Both the prevalence and the severity of dental caries increased with a decrease in the parents' level of education. In bivariate analysis, the associations were statistically significant for both prevalence and severity of dental caries. In multiple regressions, the parental education level was not a predictor of the prevalence of dental caries but the severity of dental caries was predicted by mother's level of education. The participants whose mother finished university education had less severe dental caries and this category was rendered with a significant β coefficient. The result indicates that the mother's educational level is far more important than the father's educational level for a child's or adolescent's oral health. This result is highly significant because the drop out ratio for females increases after upper primary school and the GER in higher secondary school and at university level is very low for women when compared to men because many still believe that education is not important for women who are "only mothers". Only 29% of women over 15 years are in the workforce and, in fact, India is second lowest only to Saudi Arabia for the number of women in the workforce (Rathi, 2014). Social customs and a lack of education are two main reasons that keep women at home (Verick, 2012). Economists and Sociologist in India have not made a connection between women's education and child health. The strong relationship between a mother's education and her child's health should be understood by policy makers and encourage the implementation of policies focusing on decreasing the female dropout ratio from school.

In the current study, almost 19% of participants answered that they do not know their parents' level of education. Those participants had a higher prevalence of dental caries and more severe dental caries when compared to participants who reported knowing their parents' educational level. The adolescents reporting not knowing their parents' level of education would have answered "don't know" for no education attained by their parents. The question was asked with option "8th standard or lower" for adolescents to choose when their parents did not have any education. In future studies, a separate option of "No education" should be added to avoid any possible confusion. This issue was not noticed in the pilot study because none of the participants in the pilot study selected the "don't know" option. The participants (n=49; 4%) who reported not having a father/male guardian or a mother/female guardian also reported having more oral disease prevalence.

The participants who reported that they do not have a father had less prevalence of caries when compared to adolescents who reported they do not have a mother. In contrast, the severity of dental caries was higher in those who reported not having fathers. This might be because of the likely reduction in household income in families without a father/male guardian when compared to having a only mother. In India, a higher percentage of working women are illiterate producing a “U” shaped relationship between women’s education and participation in workforce (Lahoti, 2013). The women without education who are working are likely to be in labouring job on minimum wages. About 80% of women are not in the workforce and there is a lesser percentage of working women living in urban areas (14.2%) compared to living in rural areas (26.5%) (Lahoti, 2013). This is another reason why the father is a main source of income in Indian families. Adolescents who reported not having father would have a poorer socioeconomic status compared to adolscents who reported having a father and this difference in socioeconomic status is reflected in their poorer oral health.

5.3.3.3 Location of school

The prevalence of dental caries in rural participants (64.3%) was higher than urban participants (58.07%) with the difference being statistically significant (X^2= 4.015, $p<0.05$). The DMFT average was higher for rural participants (2.22) compared to urban (1.84) participants. The result from the current study is in line with the multi-centric study results (see Table 63), and Prabhu and John (2013) study which was discussed above. In both literature relating to India and the wider international context (Phelan, Byun, Skinner, & Blinkhorn, 2009), higher dental caries prevalence and severity have been reported in rural populations (Mejia & Ha, 2011). In New Zealand, the severity of dental caries is 1.3 times higher in rural areas compared to urban areas (Ministry of Health, 2006).

This result was expected because one aim of this project has been to compare the differences in prevalence and oral health literacy between metropolitan cities, such as Chennai, where there are more facilities, with a rural area in Tamil Nadu with a much more limited access to oral health services. Chennai city has 10 private dental universities and one Government dental university all offering free oral health services. As discussed in an earlier chapter, the number of dentists in Chennai district is comparatively higher than in the Thanjavur district, which is where the rural participants were recruited from. Although the region does not have a dental college, there are primary health centres and all rural primary health centres offer free oral health services to all age groups and serve mainly those in lower socioeconomic brackets. A higher literacy rate among parents in Chennai, compared to the rural areas, combined with greater access to oral health services, effect that there is a lessened prevalence of oral disease in this urban area.

Table 63: Prevalence and DMFT average in the Current Study and Multi-centric Study for Rural and Urban areas

	Prevalence			DMFT		
Site	Urban	Rural	Total	Rural	Urban	Total
Arunachal Pradesh	51.3	45.9	48.5	1.33	1.61	1.45
Delhi	41.4	63.3	52.4	1.81	1.09	1.45
Maharashtra	64.3	52.8	58.5	1.40	1.98	1.69
Puducherry	79.0	87.8	83.4	4.39	3.71	4.05
Rajasthan	56.5	54.2	55.4	1.52	1.90	1.71
Orissa	23.1	25.6	24.3	0.65	0.54	0.59
Utter Pradesh	54.1	55.6	54.9	1.79	1.63	1.71
Current Study	58.07	64.3	61.4	2.22	1.84	2.03

5.3.3.4 Type of School

The difference in prevalence percentage between private schools (54.61%) and public schools (68.81%) was statistically significant ($X^2 = 20.675$; $p < 0.001$). In the current study, the participant's socioeconomic status was determined by the type of school he or she attended. The type of school was rendered as one of the predictors of prevalence of dental caries in logistic regression when controlling for parental education, location of school, age, gender and community/caste. One of the major reasons behind the difference in prevalence percentage between private and public school participants is the underlying difference in socioeconomic status between these schools. Another reason would be more participants from the Scheduled Caste and Tribes community (60%) were studying in the public school and this category was also rendered as an important predictor of prevalence of dental caries. Even though public school students' socioeconomic status and community were the reasons behind higher prevalence reported in this research, the poor oral health literacy skills among public school participants was also identified as the one of the reasons for higher prevalence of dental caries in the current study and this relationship is discussed further with the current study results in the final section of this chapter.

5.3.3.5 Community/Caste

The difference in prevalence of dental caries between different caste categories was identified in this study. None of the previous studies have reported the prevalence of dental caries in different caste categories in Tamil Nadu and hence there are no other studies to compare and contrast the results reported in the current study. The current study is the first to collect data and report on the oral health by different caste categories in Tamil Nadu. The prevalence percentage was statistically significant for different caste categories ($X^2 = 19.887$; $p < 0.001$). The prevalence of dental caries in Forward Caste adolescents was the lowest of all categories

(51.7%) and prevalence was highest for Scheduled Caste and Tribes community (71.8%) which is considerably higher than other castes. This result was confirmed in the logistic multiple variable regression analysis. The Most Backward Caste and Scheduled Caste were 1.08 and 1.79 times more likely to get dental caries respectively. The result implies that the Scheduled Caste and Tribes community are a vulnerable population. Out of 273 Scheduled Caste and Tribes in the study sample, about 71.8% had dental caries which is 1/3 of total affected sample population. The study result indicates that the Scheduled Caste and Tribes population are more affected by dental caries even when controlling for parental education, the type of school they go, whether in a rural or urban location, gender and age. This relationship needs further consideration by oral health policy makers.

Not only the prevalence of dental caries, but also the severity of caries was identified in adolescents who belonged to the SC/ST category. This result was statistically significant in ANOVA analysis and the caste categories “MBC” and “SC/ST” were identified as the best predictors of dental caries along with the level of the mother’s education and the participant’s gender in multiple linear regression. This result indicates that even though prevalence of dental caries was less common in the Most Backward community, the severity was higher for these participants. The Forward community had slightly more decay because their diet is vegetarian, but the prevalence was less than the Backward Caste. These results indicated that there is a strong relationship between community/caste and severity of dental caries and this relationship should be the subject for future research.

Lack of education and poor economic status for many years placed these populations’ oral health under scrutiny. Hence, in the current study it was assumed that their oral health would be poor compared to other caste communities. The current study results indicated that being in the community Scheduled Caste and Tribes (SC/ST) is the major predictor of dental caries prevalence. There are various policies in India to enhance Scheduled Caste’ or Tribes’ health, education, social status and economic status, but there are no polices that focus in particular on the Scheduled Caste and Scheduled Tribes population in regard to oral health. The oral health policies targeting the Scheduled Caste and Scheduled Tribes population, which includes 25% of total Indian population, would make a huge difference in the community because 33% of affected population in the current study were from these communities.

5.3.4 Summary

The figure 28 indicates the participant’s categories that are most affected and least affected by dental caries. More adolescents in the categories of female, Scheduled Caste and Tribes, public school and rural school had dental caries compared to the categories of male, private school, urban school, parental education at university level, Forward Caste and Backward Caste.

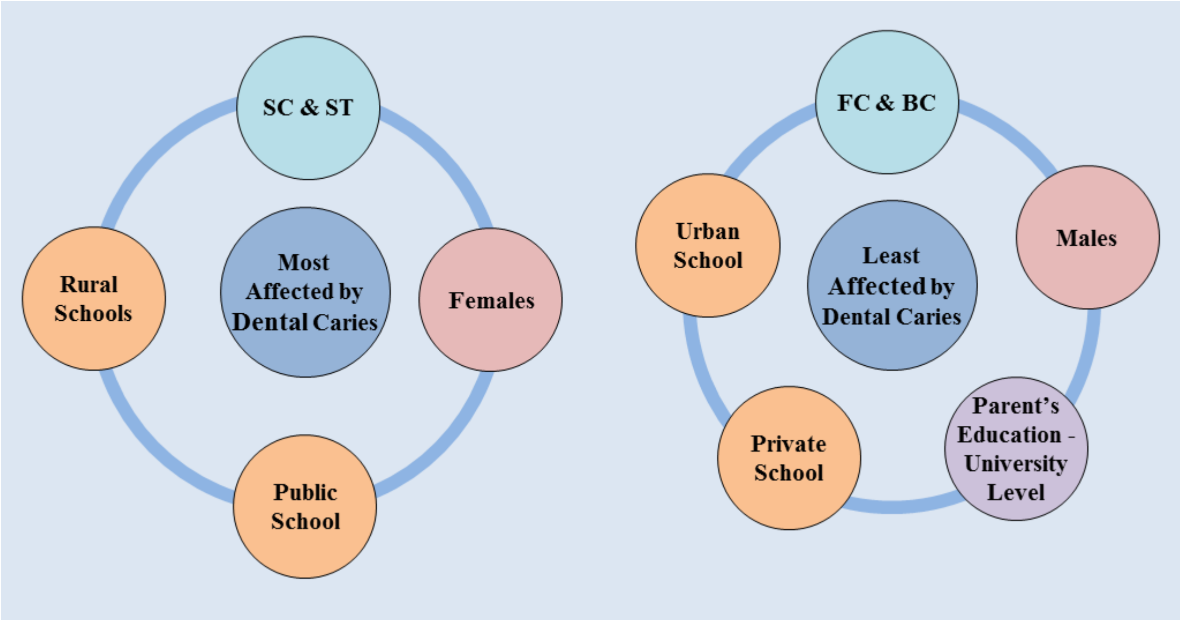

Figure 28: Prevalence of Dental Caries: Most and Least Affected

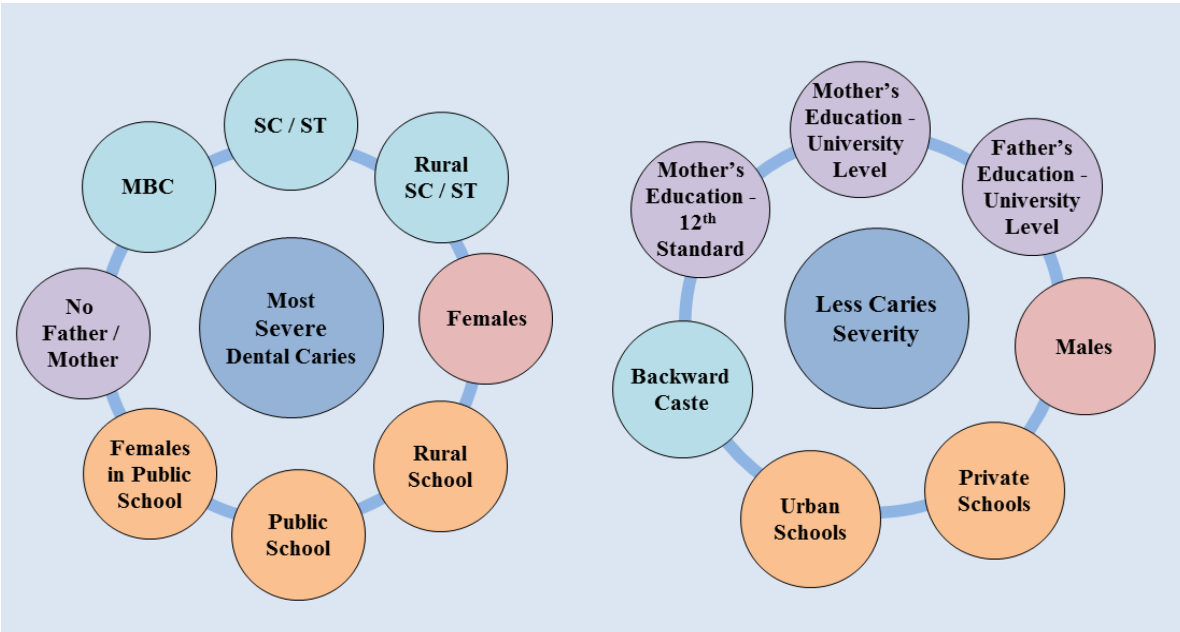

Figure 29: Severity of Dental Caries: Most and Least Affected

The severity of dental caries is higher in caste categories Most Backward Caste and Scheduled Caste/Tribes; females, participants who reported not having one or both parents; participants studying in public schools and rural schools. Females and Scheduled Caste/ Tribes caste students studying in rural schools are highly affected (see Figure 29).

The least affected categories in the current study are males; father's education at university level; mother's education at 12th standard and university level; private and urban school participants and Backward Caste. The prevalence is lower in the Forward Caste but the severity was higher than Backward community.

5.4 Research Question 2

What is the level of Oral Health Literacy among Adolescents in rural and urban schools of Tamil Nadu?

In this section, results for the oral health literacy measure are discussed. First, the itemised discussion for some important results relevant to hygiene practices, eating habits and adverse oral habits are presented. This is followed by a discussion of the constructed oral health literacy measure results and the relevance to academic literature .

5.4.2 Oral Health Practices

5.4.2.1 Brushing Habit

In the current study, 92.6% of participants reported that they used toothpaste for brushing and 88.1% stated using a toothbrush every day. About 1.5% of participants reported that they never used toothbrush and toothpaste. Only 32.6% of participants reported that they brush more than once every day.

5.4.2.1.1 Brushing habit in current study and International literature

Eaton and Carlile's (2008) study, conducted in Europe, indicates that brushing more than two times everyday among 11 year olds is between 89% and 36% (M. Lee & Dennison, 2004). This study indicated that females tend to brush twice as often as males. These results are keeping with current study results. In the current study, 31.7% of males and 34% of female participants reported that they have brushed more than once daily. A report from Australia indicates that 66% of 12 year olds brushed more than once daily (See Figure 30). A New Zealand report indicated that almost 59% of adolescents brushed more than once daily and also reported that frequency decreased between 2-11 year olds (66.5%) and 12-17 year olds (59.0%). Even in the current study, up to 34.5% of 12 year olds brushed more than once daily but only 30.1% of 15 year olds brushed twice daily. This result implies that when child grows the parents' attention towards child's oral health deteriorates and adolescents with poor oral health literacy tend to ignore their oral health. A proper oral health education is required to improve oral health literacy as adolescents are expected to take care of their oral health.

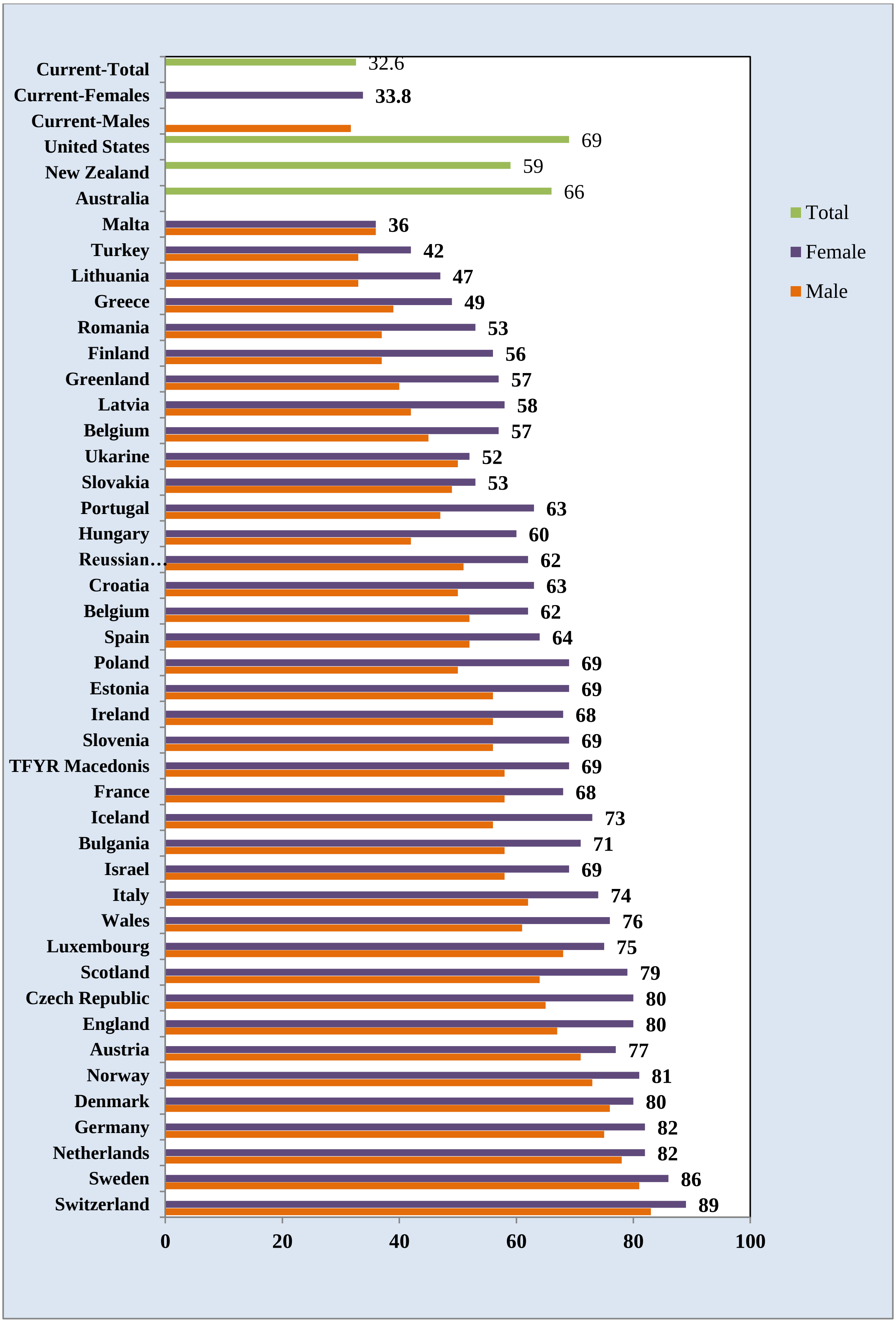

Figure 30: Tooth Brushing Percentage: International and in the Current Study

5.4.2.1.2 Brushing habit in current study and other studies in India

The study results are in line with studies done in other parts of India and districts of Tamil Nadu (Joshi, Rajesh, & Sunitha, 2005; Priya, Devdas, Amarlal, & Venkatachalapathy, 2013; Punitha & Sivaprakasam, 2011; Shah et al., 2007; Suprabha et al., 2013). The studies conducted in the urban location of India reported that more than 95% of participants use a toothbrush. The rural studies reported comparatively less participants using a toothbrushes and toothpaste (between 55.6% and 75%) (See Table 64). The multi-centric study reported that between 89% and 100% self-reporting 15 year old participants used a toothbrush every day (See Table 64). Puducherry had the highest rate and, as previously noted, Puducherry participants had a higher prevalence of dental caries when compared to other states in India. This result suggests that tooth brushing habits alone will not prevent dental caries and that the consumption of sugary snacks may have greater influence on the prevalence of dental caries. For this reason, an itemised analysis for questions on sugar intake habits were also undertaken in the current study.

Table 64: Brushing habit in the Current Study and Different Parts of India

Study	Site	Toothbrush	ToothPaste	Floss
Joshi et al.(2005)	Kulashekharam, TN	75%	75%	-
Punitha et al.(2011)	Kancheepuram, TN	62%	55.5%	-
Priya et al.(2014)	Chennai, TN	98%	98%	4%
Suprabha et al. (2013)	Mangalore, Karnataka	97.7%	96.4%	-
Multi-Centric Study (2007)	Arunachal Pradesh	95.2%	-	-
Multi-Centric Study (2007)	Delhi	89.2%	-	-
Multi-Centric Study (2007)	Maharashtra	98.5%	-	-
Multi-Centric Study (2007)	Puducherry	100%	-	-
Multi-Centric Study (2007)	Rajasthan	90.5%	-	-
Multi-Centric Study (2007)	Orissa	100%	-	-
Multi-Centric Study (2007)	Utter Pradesh	95.4%	-	-
Current study	Thanjavur & Chennai	88.1%	92.6%	4%

5.4.2.2 Sugar intake

The sugar intake of the current study participants was compared with that of the Delhi area by using data reported in the 2007 Multi-Centric Study. The findings of both the current study and Joshi et al.'s study (2005) indicate that Tamil Nadu adolescents consume less sugar containing snacks and beverages compared to other sites in India. To understand the overall sugar intake by the participants, all items for sugar intake were combined and from this it is evident that 57.4% of participants consumed and produced similar findings of 58.6% in (Punitha & Sivaprakasam, 2011) study in Kanchipuram district, Tamil Nadu .

These results indicate a lack of awareness among adolescents regarding the effect of sugary food on dental health. This result suggests that rather than just improving the brushing habit, decreasing the sugar intake has a greater influence on preventing dental caries. Currently, implementing a brushing habit is a major part of oral health promotion programmes conducted by the Indian Dental Association. The current study results indicates that although compared to past studies the number of participants using a toothbrush and fluoridated toothpaste has considerably increased, future oral health promotion should include an awareness programme for reducing sugar intake. For example in Indian families, drinking coffee, milk or tea with sugar is very common, a behaviour pattern that was reported by the participants in the current study. About 72.5% of participants reported that they drink milk/coffee/tea with sugar and 25% of them reported drinking those beverages a several times a day. In recent years, availability of sugar rich snacks and food has increased both in rural and urban parts of Tamil Nadu. It is therefore crucial that oral health promotion programmes should give greater importance to promoting sugar free food and drinks; for example, schools should promote sugar free lunches.

Table 65: Sugar Intake in the Current Study and Past Studies

Study	Site	Several Times a day		
		Bakery Sweets	Other sweets	Beverages
Suprabha et al.(2013)	Mangalore, Karnataka	9	10.7	6.9
Punitha et al.(2011)	Kancheepuram, TN		58.6	
Joshi et al.(2005)	Kulashekharam, TN		5.9	
Kuppuswamy et al. (2014)	Chennai	44	33	33
Multi-Centric Study (2007)	Arunachal Pradesh	28.5	23.2	11.3
Multi-Centric Study (2007)	Delhi	18.9	12.9	24.3
Multi-Centric Study (2007)	Maharashtra	39.5	15.0	9.1
Multi-Centric Study (2007)	Puducherry	54.0	43.2	4.8
Multi-Centric Study (2007)	Rajasthan	5.0	48.3	6.4
Multi-Centric Study (2007)	Orissa	32.8	18.6	1.1
Multi-Centric Study (2007)	Utter Pradesh	54.1	53.7	19.6
Current study	Thanjavur and Chennai	20.7	19.8	8.6

5.4.2.3 Tobacco usage

A systematic review study conducted by(World Health Organisation, 1997) reported that tobacco usage leads to oral health related diseases such as periodontitis, dental caries, oral carcinoma, implant failures, and tooth loss because of periodontitis and a failure of restorations. In the current study, 5.1% of (14 and 15 year olds) participants reported that they smoked or/and chewed tobacco at least once a week. The number of participants who used tobacco in the current study was higher for Thanjavur (n=34) district than Chennai (n=16). Lin and Mauk (2012) reported that Thanjavur district has a higher prevalence (30%) of tobacco usage compared to the state-wide average (12%) with more male adults reported chewing tobacco. In the current study, the majority of participants who reported smoking were males from the rural schools of Tamil Nadu. This result suggests that the higher prevalence of tobacco usage among the adults as reported by Lin and Mack (2012) has an impact on adolescents. The multi-centric survey reported (See Table 66) a higher usage of tobacco product in Arunachal Pradesh and Rajasthan, which are northern states in India. All other areas reported a very minimal usage of tobacco by fifteen year olds. The current study results are in keeping with the reports for Arunachal Pradesh. Harikiran et al., (2008) reported a slightly higher tobacco use in Bangalore city, in South India. A study conducted in the Kanchipuram district reported that none of the study participants consumed tobacco products but the study age group was 5-10 years which is very early to start using tobacco products. When the current study results are compared with international reports, tobacco usage is comparatively lower among current study participants. The Centres for Disease Control and Prevention reported that in the USA 6.7% of middle school students and 23.4% of high school students used tobacco products, which include cigarettes, cigars, hookahs, snuff, smokeless tobacco, pipes, bidis, keteks, dissolvable tobacco, and electronic cigarettes (Shah et al., 2007). According to the multi-centric study report, tobacco usage rates among adolescent boys aged 15 year old is 18% (Shah et al., 2007) . In New Zealand, up to 13% of 13-17 year olds are reported being regular smokers and an Australian report states that in 2011, 16% of males and 13% of females are regular smokers by the age of 17 (Australian Institute of Health and Welfare, 2012) . Although tobacco usage among the Indian adolescent population is lower when compared to data reported in international studies, the current study reported a higher tobacco usage among adolescents compared to earlier data reported in Indian studies.

Table 66: Tobacco Usage in the Current Study and Past Studies

Site	Study	Total %
Arunachal Pradesh	Multi-Centric Study (2007)	5.2
Delhi	Multi-Centric Study (2007)	0.8
Maharashtra	Multi-Centric Study (2007)	0.1
Puducherry	Multi-Centric Study (2007)	1.2
Rajasthan	Multi-Centric Study (2007)	13.1
Orissa	Multi-Centric Study (2007)	2.8
Utter Pradesh	Multi-Centric Study (2007)	0.1
Bangalore	Harikiran et al.(2008)	5.6
Current Study	2012	5.0

Some studies in Tamil Nadu in the early adolescent age group that sought to identify oral health knowledge, behaviour, and practices did not identify tobacco usage (Prasad, Shankar, & Priyaa, 2010; Priya et al., 2013). This might be because tobacco usage is not usually expected in an Indian adolescent age group and therefore not investigated or because of school management would not give permission to ask such sensitive questions of school children. In the current study, most schools gave permission to ask participants tobacco related questions once an explanation as to its importance had been given. Because tobacco usage is comparatively higher in the Tamil Nadu region when compared to other states of India, it was important for studies conducted in Tamil Nadu state to ask tobacco related questions even of those in early adolescence. Oral health promotion interventions should stress the adverse effects of tobacco usage on oral health especially.

In conclusion, in the current study the majority of participants had a habit of brushing using a toothbrush and fluoride toothpaste, but consumption of sugary snacks and beverages compromised their oral health. And, given that tobacco usage is high compared to earlier indications, an urgent intervention is required to prevent a more widespread uptake of smoking in the Tamil Nadu region.

5.4.3 Oral Health Literacy

In the current study, the level of oral health literacy of adolescent participants was measured using a self-administered OHL questionnaire. There are five components to the questionnaire: basic oral health knowledge, oral health behaviour, oral health attitudes, self-managing skills, and a measure of comprehension skills. Each item in the questionnaire was individually scored based on its contribution to oral health literacy. A total score of the individual components was calculated and component scores were added to calculate the final oral health literacy score.

The total oral health literacy score was divided into three categories based on previous studies in the literature. In total, 35% of participants had a poor OHL score for prevention of dental caries and only 8.3% of adolescents had good OHL skills for prevention of dental caries. The Chi-square analysis indicated that every socioeconomic variable was associated with oral health literacy categories except for the participant's age.

The raw health literacy scores were further analysed to understand the associations with different socioeconomic variables to avoid missing any information from dividing the scores into three categories. The bivariate analysis indicated that, age excepted, all sociodemographic variables were associated with oral health literacy scores. The multiple variable regression analysis indicated the categories, gender, mother's education at university level, and SC/ST as a predictors of oral health literacy skills.

5.4.3.1 Interpretation of Findings

The total oral health literacy scores for the overall sample were normally distributed with mean score of 32.27 out of 50. Thirty five percent of participants had poor oral health literacy which indicates that their current level of OHL skills was likely to be insufficient to prevent and manage dental caries. Only 8% of participants were considered to possess enough oral health literacy skills to assist in prevention of dental caries, self-manage dental caries, and participate effectively in the oral healthcare decision making process with basic oral health knowledge and comprehension skills. An intervention to improve oral health literacy is needed for both rural and urban school students whether they attend either private or public schools.

5.4.3.2 Gender

Female participants scored slightly higher than males on OHL. This result was in keeping with adults' oral health literacy studies in international literature (Naghibi Sistani, Yazdani, Virtanen, Pakdaman, & Murtomaa, 2013; Sistani, Yazdani, Virtanen, Pakdaman, & Murtomaa, 2013). The further analysis of the individual components of oral health literacy indicated that the females scored higher for the oral health behaviour score and this is also reported in another study (Naghibi Sistani et al., 2013). Even though the concept of measuring oral health literacy was different in Ueno et al.'s (2014), study which is based on visual drawing to measure OHL, the study results indicate that females had higher oral health literacy than males. An India health literacy study conducted among adult patients seeking dental care reported females scoring higher than males in health literacy skills (D'Cruz & Shankar Aradhya, 2013). Females scoring higher than the males in both adolescent and adult age groups is a common trend in both international and India based literature.

5.4.3.3 Parent's Education

The adolescents whose parents had a university education have scored higher than other participants. This result is similar to other studies that were conducted among adult populations which demonstrated that the oral health literacy score increased with an increase in the level of education attained, and university graduates scored highest in those studies (K. A. Atchison et al., 2010; M. Jones et al., 2007; Jessica Y. Lee et al., 2011; Dania A Sabbahi et al., 2009). Oral health literacy studies conducted among parents also indicated that a parent's oral health literacy, relating to a child's oral health increased with an increase in parental educational attainment (Divaris et al., 2011; Veerasamy & Kirk, 2014). Although the studies mentioned above were conducted among adult participants, the relationship between level of education in adults and oral health literacy is consistent with the current study result. This indicates that the education has a strong influence on the level of oral health literacy. For the state of Tamil Nadu, decreasing the secondary and the higher secondary dropout ratio, especially for females, would have a strong influence on improving the oral health literacy of the population and in turn the oral health outcome of the community.

The current study result also indicated that the adolescents who reported not having one or either of their parents scored less which indicates that the parents could be one of the main sources of an adolescent's oral health literacy skills. Any oral health literacy intervention for children/adolescents should consider involving parents rather than just doing an intervention through school or oral health professionals.

5.4.3.4 Location and type of School

The rural and public school participants scored lower oral health literacy scores than urban and private school participants, respectively. This is an expected result for the current study because compared to rural school participants the Chennai school participants have more exposure to oral health-related knowledge because of an increase access to oral health services compared to rural school students. Moreover the education levels of the parents of participants who are at urban schools were comparatively higher than the education levels of parents of rural school participants.

The public school participants scored less than private school participants in the oral health literacy measure. The reasons for this result would be the higher socioeconomic status of the parents and comparatively better literacy level among adolescents. There is no study available to compare the results of oral health literacy for adolescents or adults in Tamil Nadu, but as discussed previously. Mahesh et al.'s (2005) study indicated that private school students have better oral health behaviour when compared to public school participants.

5.3.4.5 Community/Caste

Oral health literacy was strongly associated with different caste categories in the bivariate analysis. The descriptive mean scores indicated that Forward Caste people scored highest and Scheduled Caste and Tribes scored very low among all caste categories. This is an expected result for the current study. In the current study, only 1.6% of participants from the total Forward Caste reported that their parents have education level less than 8^{th} standard but in other caste categories between 22% and 44% of participants reported that their parents had education level at or below 8^{th} standard. This explains the reason behind highest score among Forward Caste. This result also further demonstrates the strong correlation existing between the parents' level of education and adolescents' oral health literacy scores.

Not only did the majority of Scheduled Caste and Tribes community participants' parents have a lower of education, but they were also in lower socioeconomic groups. A further analysis was conducted by splitting the sample based on rural-urban and private-public and a regression analysis with interaction was performed. The results indicated that the SC/ST category was a predictor of oral health literacy but not when the sample is divided into rural and urban. This indicates that Scheduled Caste and Tribes studying in both rural and urban schools scored less in oral health literacy skill. For the participants from the Most Backward community category, studying in a rural school is a predictor of oral health literacy such that the Most Backward Community participants in the rural area scored less than their urban counterparts. This result indicates that Scheduled Caste/Tribes (SC/ST) living in both urban and rural areas lack oral health literacy skills and Most Backward Community participants in rural area lack oral health literacy skills when compared to others. In India, the caste discrepancies and inequalities are strong and persist more in rural areas than urban areas. Hence, an oral health literacy intervention should be targeted for Scheduled Caste and Tribes (SC/ST) adolescents all over Tamil Nadu and Most Backward Caste should also be targeted in the rural parts.

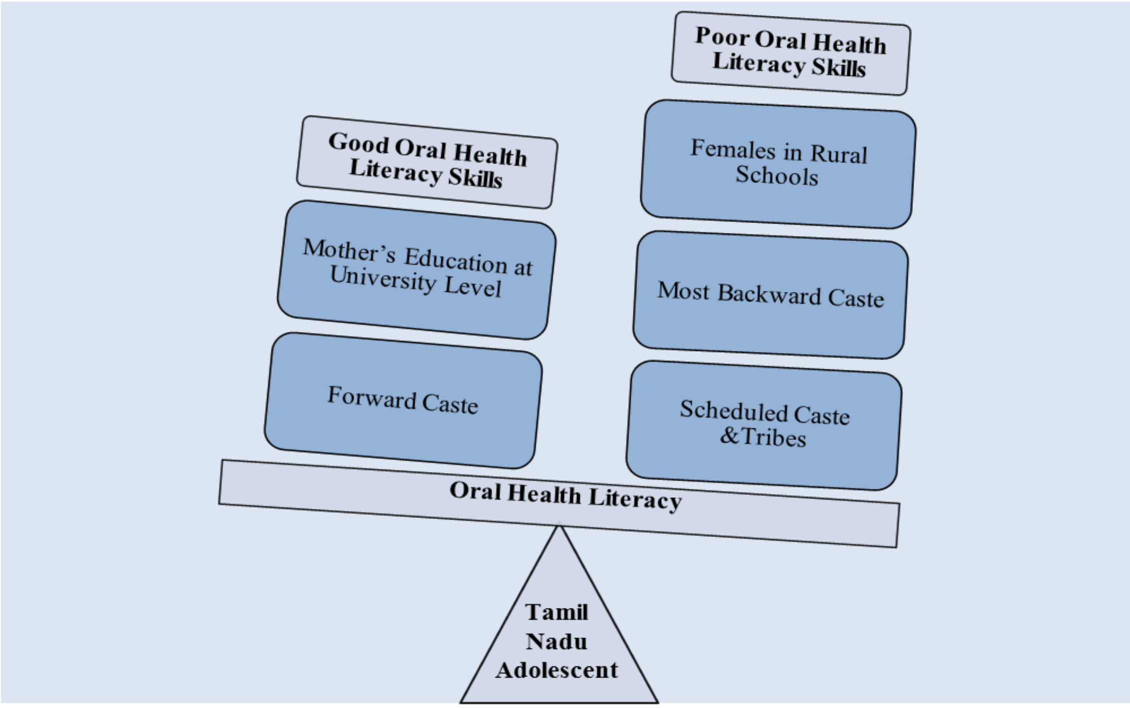

Figure 31: Oral Health Literacy Skills among Different Socioeconomic Variables

In conclusion, oral health literacy skills are higher among females for the total sample but females in rural schools have poor oral health literacy. Participants from Scheduled Caste and Tribes community had poor oral health literacy when compared to other participants in the total sample and for rural schools even the Most Backward Community participants had poor oral health literacy skills (See Figure 31). The participants' mother who completed university education and those from the Forward Caste had better oral health literacyskills to prevent and manage dental caries. In the next section the association between oral health literacy scores and DMFT scores are presented.

5.5 Research Question 3

What is the association between Oral health Literacy and Severity of Dental caries?

5.5.1 Summary of Findings

The results indicated a strong correlation between oral health literacy scores and DMFT scores. The oral health literacy categories were strongly associated with the prevalence of dental caries and the participants who were most affected by dental caries had poor oral health literacy. The DMFT scores were negatively associated with OHL scores. This relationship is statistically significant with a negative correlation coefficient value reported in the Pearson correlational test. Oral health literacy is a predictor of DMFT when regressed by controlling for gender, parental education, age, location of school, and type of school.

5.5.2 Dental Caries and Oral Health Literacy

The statistically significant association between dental carries severity/prevalence and oral health literacy is identified in the current study. There is no study available to compare the current study results with previous studies but the findings are consistent with studies conducted among adult populations to understand the association between oral health literacy and oral health status.

The statistical association between oral health literacy and periodontal status was identified in a study conducted among adults patients in a periodontal clinic (Wehmeyer, Corwin, Guthmiller, & Lee, 2014). Wehmeyer et al.'s study reported an increase in the periodontal index with a decrease in oral health literacy. In the current study, as the OHL score in the adolescent population decreased the DMFT index increased.

An Australian study conducted among indigenous adults indicated a correlation of poor oral health literacy scores with poor self-reported oral health domains such as perceived gum disease, perceived need for filling and extraction, and poor oral health related quality of life (Eleanor J Parker & Jamieson, 2010). Another American study also indicated an association between oral health literacy and failed attendance at a dental appointment in a university based general dental clinic (Holtzman, Atchison, Gironda, Radbod, & Gornbein, 2014). Lee et al., (2012) identified a correlation between OHL and self-reported oral health status and dental neglect (Jessica Y. Lee, Divaris, Baker, Rozier, & Vann, 2012).

The current thesis appears to be the first to examine an adolescent population's oral health, conduct oral health survey to measure oral helath literacy and to report on the association between oral health literacy and its correlation with dental caries. Most earlier studies discussed above have correlated OHL with self-reported oral health status and dental neglect. Clinical oral health examinations were not performed in those studies except for the study conducted by Wehmeyer et al., (2014) in which the periodontal index was compared with oral health literacy in among periodontal patients.

In the oral health literacy literature, initially adults' oral health literacy was measured and the importance of oral health literacy in adults was stressed in many studies. In the recent years, the importance of the parents' oral health literacy and its impact on the child's oral health outcome has been well investigated in many studies and these have been discussed above in the literature review chapter. The current study is the first study to signpost the impact of poor oral health literacy among an adolescent population on their oral health status.

The current study recognises five components to oral health literacy: basic oral health knowledge, oral health behaviours, oral health attitude, self-managing skills, and comprehension knowledge. The scores from these individual components were regressed with mean DMFT scores to identify the important predictors of dental caries among five components of oral health literacy. The multiple linear regression analysis indicated that oral health knowledge, oral health attitudes and self-managing skills are important predictors of DMFT. Oral health behaviour and comprehension skills were not identified as predictors of DMFT scores. This result is unusual for dental caries prevention literature because the relevant literature identifies a correlation between oral health behaviours and better oral health.

The oral health behaviour scores are associated with DMFT scores in the bivariate analysis but it is not a predictor of DMFT when controlling for the other components of oral health literacy. This relationship was further investigated by re-examining the descriptive analysis which indicated that females and public school participants scored higher than male and private school participants respectively in the behaviour components. Despite the fact that females and public school participants had good oral health behaviour, they had more dental caries than males and private school participants respectively. Rural school females' oral health would be compromised because of a lack of access to healthy food, limited oral health knowledge, and poor self-managing skills. This result implies that, for better oral health not only is good oral health behaviour required, but oral health literacy skills are also mandatory.

Traditionally, oral health behaviour alone is considered a deciding factor for good oral health but the results of the current study suggest that oral health literacy is also important to prevent decay. For participants who brushed twice daily their attitude toward brushing and knowledge on brushing has an impact on efficiency of plaque removal. For this reason, oral health promotion campaigns should include more sophisticated information regarding brushing technique and plaque removal and should also focus on changing attitudes through improved oral health knowledge. In the current study, almost 45% of participants agreed that brushing twice daily is important but only 14% of participants reported that they were indeed brushing their teeth twice daily. This difference in attitude and behaviour can only be changed by improving knowledge regarding the importance of, and techniques for brushing teeth; hence, for preventing dental caries oral health literacy skills are necessary. Recommendations for improving oral health literacy are provided in the next chapter.

5.5.3 Unexpected findings

The results indicated that "gender" and "Scheduled Caste/Tribes" categories are important predictors of DMFT along with oral health literacy when regressed with all socioeconomic variables. Even though DMFT scores decreased with an increase in oral health literacy scores, females scored higher than male participants in the OHL measure but their DMFT scores remained higher when compared to male participants. This result suggests that is because of the nature of the oral environment, dental anatomy and early eruption of teeth in females, compared to male counterparts, females are expected to have more oral health literacy skills to prevent and manage dental caries. The thesis results also show that females scored higher for oral health behaviour but even so their DMFT average and prevalence rate is still higher than male participants. This suggests that females need to follow a healthier diet to prevent dental decay.

In the current study, females in rural areas scored lower on the oral healthy literacy scale when compared to their urban counterparts. Despite this fact, females in rural schools scored higher in behaviour components when compared to males. From this result it can be seen that females in the rural areas of Tamil Nadu are at risk and there is the need for an urgent intervention with respect to nutrition and other gender disparity issues in rural Tamil Nadu. In the next chapter, recommendations for improving oral health literacy are presented.

Chapter 6: Recommendations and Conclusions

6.1 Recommendations

The thesis study results show that the prevalence and severity of dental caries has increased among the Tamil Nadu adolescent population. Limited oral health literacy is one of the reasons behind the poor oral health status as identified by the association between OHL scores and DMFT scores. In the next section, recommendations for educators, policy makers, parents, teachers, health professionals, the Indian Dental Association, and the Indian Dental Council are presented.

Recently, the Tamil Nadu Government implemented a“rural oral health scheme” in 2008 in which free oral health services are provided for rural areas through 360 primary health centres. Despite this recent community effort, the prevalence percentage and DMFT average is still higher for Tamil Nadu state when compared to other states examined in the Multi-Centric Survey and also as reported by other studies conducted in differing parts of India. The current study result indicates the DMFT average and prevalence of dental caries are higher for rural school participants and that these adolescents have a considerably higher number of untreated dental caries. This result denotes that the availability of oral health services through 360 primary health centres did not serve every rural population which also includes the adolescents. In the current study, 91% of adolescents indicated that they never been to dentist which is the highest reported among the studies conducted among Indian adolescent population.

In the current study, females and lower caste participants living in rural areas were most affected by dental caries and the relative risk of poor oral health literacy was also noted among these participants. This suggests that the females and lower caste people living in rural areas need an urgent intervention. Figure 32 indicates the key results and implications for the results.

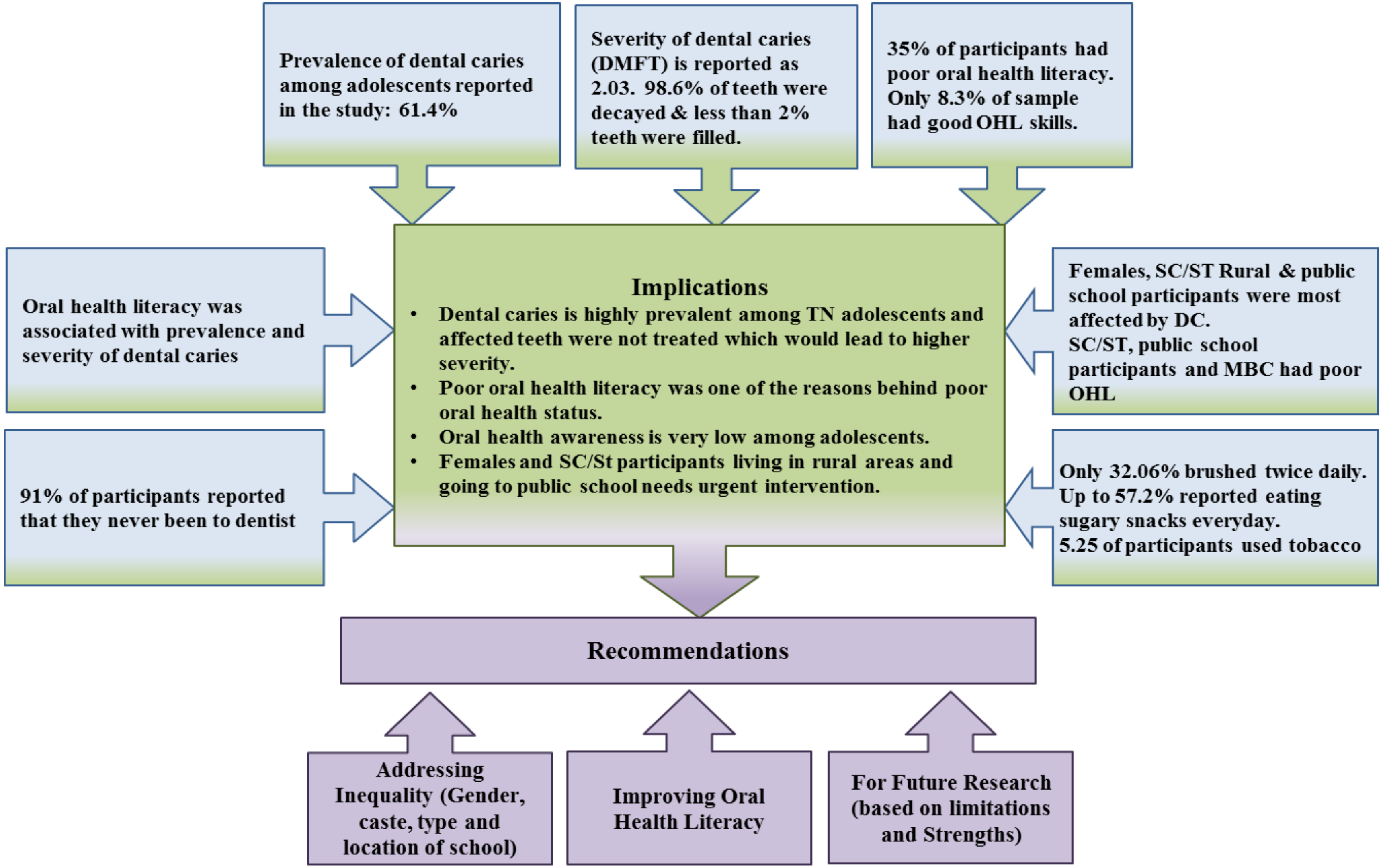

Figure 32: Summary of Results, Implications and Recommendations

6.1.1 Recommendations to prevent dental caries by improving oral health literacy

Improved oral health literacy is essentially an outcome of good oral health promotion. The Ottawa Charter (1986) indicates that oral health promotion should focus at the population level not just focus on individuals at risk (World Health Organisation, 1986). Health education has been an essential component of health promotion for the last 50 years. Nutbeam commenting on the history of health education programmes notes that the programmes of 1970s were found to be effective only among an educated and economically advantaged population (D. Nutbeam, 2000). Nutbeam explains that in the 1980s, the health education was considerably strengthened by more sophisticated theory-informed interventions focusing on helping to develop personal and social skills required to make positive health behaviour choices (D. Nutbeam, 2000). In late 1980s social marketing was used as a creative approach to enhance attitudes towards health by improving the communication of information to wider sections of the population. Even though there has been extensive progress in health education programmes, health promotion that relied on intervention (which is primarily based on communication and education) has failed to achieve changes which are sustainable over time (D. Nutbeam, 2000). Recent epidemiological analysis in most developed countries indicates that health status is not influenced by individual characteristics and behavioural patterns but determined by social, economic and environmental circumstances (D. Nutbeam, 2000). Such an approach is very important to influence positive oral health behaviours and attitudes.

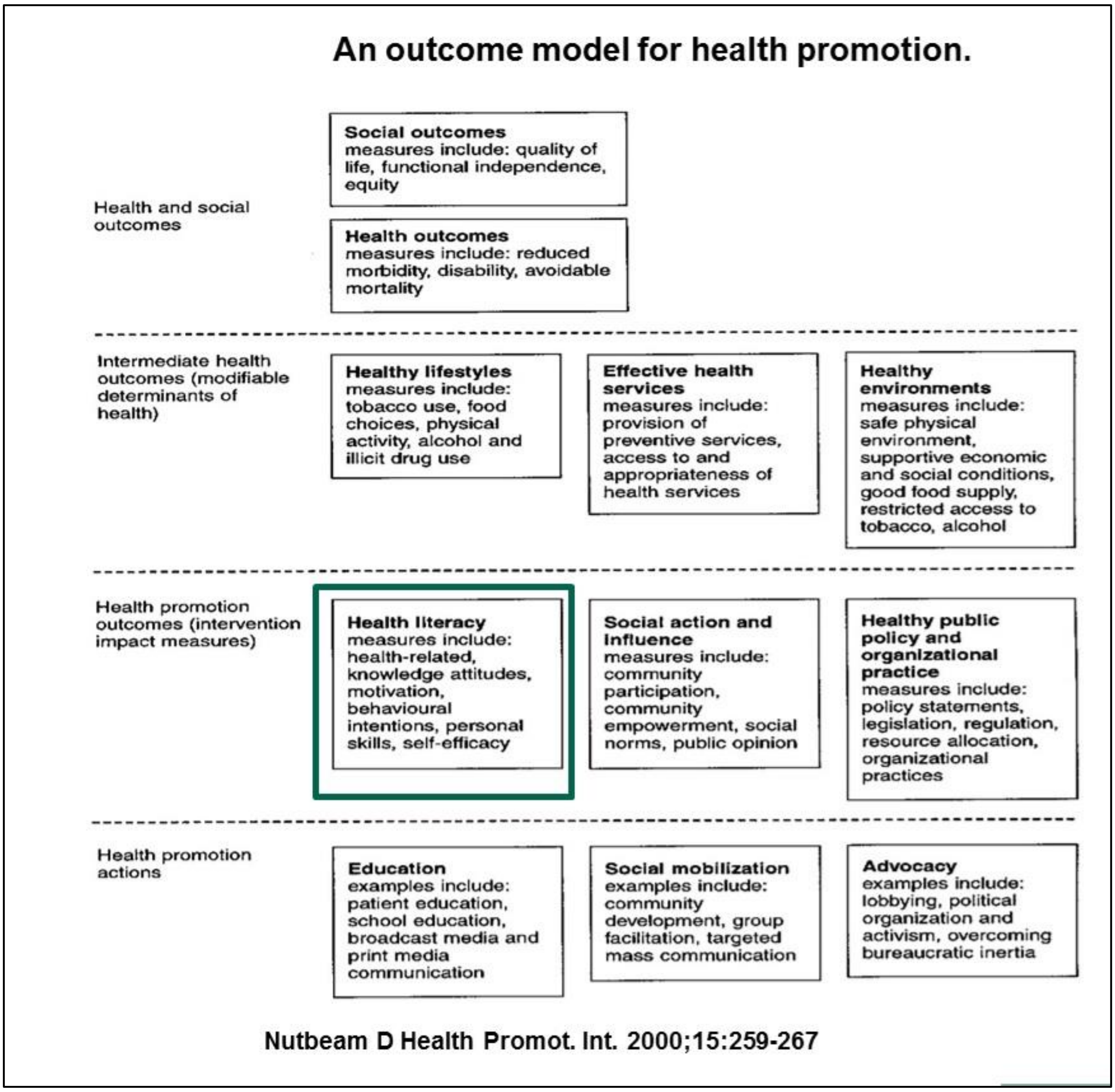

Figure 33: *Nutbeam's Outcome Model for Health Promotion (D. Nutbeam, 2000)*

In the health promotional outcome model (Figure 33) described by (D. Nutbeam, 2000), "health literacy" refers to the outcome in personal, cognitive, and social skills at individual level rather than at the community level and on this basis oral health literacy is an outcome at an individual level which is a result of oral health promotion. When looking at the history of oral health promotion, outcomes achieved because of oral health promotion at the individual level were comparatively low. This is further explained by looking at the history of the prevention of dental caries and also at the success stories in developed countries. The successful oral health outcomes achieved by developed countries such as Australia and New

Zealand have been achieved only through community-wide efforts, such as water fluoridation and free school dental services. Although school dental services and water fluoridation were combined with health education, the differences in DMFT rates between fluoridated and non-fluoridated cities and the inequality between rural and urban areas indicate that health education has a minor role in preventing dental caries. A study on the history of dental caries in Japan indicates that the severity of dental caries was less when the public did not have access to sugar between 1957 and 1987 as a consequence of the Second World War (Miyazaki & Morimoto, 1996). The prevalence of dental caries increased after the restrictions on sugar were removed (Miyazaki & Morimoto, 1996). This suggests that if access to oral health services and fluoride in water are reduced without controlling the availability of sugar, achieving a reduction in dental caries would be difficult. This argument recognises that reducing access to sugar and increasing fluoride in water were major reasons behind controlling dental caries rather than brushing and using fluoride toothpaste. This relationship is one that has already been explained in the discussion chapter.

The traditional and contemporary ways of oral health promotion (by providing oral health information and through communication) have not worked well when it comes to oral health promotion, especially dental caries. Even flossing, brushing twice daily and using fluoride toothpastes were shown to be well achieved only among the highly educated and the higher socioeconomic population, but not with the disadvantaged. The internet era has decreased the difficulty on providing the health information and also increased the availability of oral health information. The future oral health promotion should be focussed on improving oral health literacy, especially attitudes towards oral health promotion rather than simply strengthening the oral health promotion strategies. Education has a strong influence on oral health literacy and improving oral health literacy at the individual level requires multifactorial influences. Although oral health literacy is measured based on different components such as behaviour, attitude, basic oral health knowledge, comprehension skills, and self-management ability, oral health literacy could be improved by changing the individual's attitude towards oral health and oral health promotion.

For example, to modify one's behaviour towards flossing, the individual needs information not only on how and when to floss but the reasons why to floss. Reasons such as the effects of food getting stuck between the teeth, bacterial colonies, acidic oral environment due to bacterial metabolism, dental caries, gingivitis and periodontitis, bone loss in between teeth, and early tooth loss are all potent reasons to floss. It would be hard for any oral health promoter to explain these reasons to someone without a basic education and background knowledge. But it would be easier for a child to learn how to floss from a mother who regularly flosses. This is an example of why oral health literacy education should be done "by" people rather than "on" or "to" people (D. Nutbeam, 2000). In other words to be an oral health literate society, as a first step, everyone whether they are a member of the public, or a professional, a policy maker or a politician should be oral health literate.

For anyone to sustain the skills of oral health literacy, strong support from the community is needed. As an example, a mother, who has a high level of oral health literacy, has this compromised if when she goes to a supermarket with her child, sugar-rich foods are kept in child-friendly locations, because it is difficult to withstand the child's emotional pressure to purchase sweets. There is further pressure because the sugar-rich items are less expensive to buy than a healthier alternative. It is therefore important, to maintain any achieved oral health literacy relating to dental caries, that more comprehensive community support is needed. Tobacco control is achieved in many countries by communicating the risk, by strategies to reduce demand by placing restrictions on promotion, increasing the price, reducing the supply, and also by an increasing social unacceptability, reflected in environmental bans (D. Nutbeam, 2000). This approach not only addresses individual behaviour but also the underlying social and environmental determinants. This has not yet been achieved in the prevention of dental caries, partly because of the nature of the disease and partly too because of the outcome of the disease itself.

It would be easier to create a "health literate public" for any highly infectious communicable disease such as Ebola, because of high mortality rates and the rapidly spreading nature of that disease as well as the scary nature of the disease itself in the public's perception. In this case, information provided by health promoters will reach the community in a short space of time, because of the "attitude" shown by the public (especially educated) and policy makers who not only know about the disease and how to prevent its spread, but also how to treat it in the case of dental caries, getting the public's attention is very difficult because it is a chronic disease and most people think that it is easier to have a tooth extracted than to change behaviours to prevent the problem. Because of this, the first stage of oral health literacy education for any community should be making the public understand the importance of oral health and teeth care by providing wider access to oral health services and exposing the public to the importance of oral health by all possible approaches. The gap between general health and oral health should be decreased and more emphasis given to oral health.

Compared to developed countries, developing countries, like India, oral health is still ignored even among policy makers and health professionals because of the higher priority given to more infectious disease such as Tuberculosis and AIDS. Improving access to oral health services, providing more oral health information in school education, improving the importance of oral health literacy awareness among policy makers and health professionals, and emphasising the importance of oral health through media are the first steps in creating an oral health literate community in Tamil Nadu. For these reasons, recommendations in the current thesis are focussed on creating an oral health literate community rather than strategies for strengthening the oral health education and other oral health promotion activities.

6.1.1.1 Improving overall literacy rate and University enrolment

In the current study a strong correlation between the mothers' and fathers' level of education, in particular the mothers' level of education, and adolescents' DMFT and OHL scores was identified. This suggests that improving the general literacy level of the whole population by decreasing the school dropout ratio and also increasing the higher secondary school and university enrolment ratios would decrease the prevalence of dental caries by improving oral health literacy skills.

Decreasing the dropout ratio for females at higher secondary school and increasing the enrolment ratio for females in university education could be an effective long term intervention to improve the health and oral health status of the next generation of children and adolescents. The current policy on increasing university enrolment is that all poor females are given free university education and on completion of the diploma or degree they each receive marriage assistance of INR 50,000 (NZD 1,100) and a 4 gram gold coin. This policy could be strengthened by increasing the subsidy amount and also providing a further assistance for high achievers. This may motivate the disadvantaged and lower caste female population to complete university education. The high correlation existing between university education and oral health literacy in the current study and past studies indicates that enhancing education is an effective means of improving oral health literacy. Because of this, the Tamil Nadu Education Department and the Department of Health and Family Welfare could consider strengthening the current policies, as suggested, to improve the general literacy rate for females and Scheduled Caste/ Tribes because this would make a difference in oral health outcomes of the rural population. In 2010 the Government of India passed the Women's Reservation Act which provides reservation of 33% for women for places in educational institutions and a quota of 33% employment across all Government sectors (The Times of India, 2010, March 9). Although this has been passed at national level, it has yet to be enacted by the state Governments, including Tamil Nadu. Ratification by state Governments will improve the socioeconomic, political, cultural and health situation of female population.

6.1.1.2 Improving the access to oral health services

At present, only 25% of the 1,421 primary health centres that cover the entire Tamil Nadu rural population provide free oral healthcare. Oral health services should be extended to every primary health centre. Currently, the oral health services are provided in the day time on week days when young children and adolescents normally go to school. The services currently provided by the Tamil Nadu Government through the Primary Health Centres should be extended to the after school hours or else could be provided at the school campus to improve the access to oral health services for school children/adolescents. The current public school general health check-up, which at present is conducted annually, should be reviewed to include oral health check-ups, and ideally these should be conducted and 6 monthly. In addition to providing oral healthcare in primary health centres, taluk hospitals, district hospitals and medical college hospitals should also have dental units so that all socioeconomic groups receive adequate oral healthcare in Tamil Nadu.

Each district should have an oral health promoter to promote oral health literacy among the adolescent population to prevent oral health diseases. In the current study both private and public school adolescents had poor oral health literacy, and therefore, both private and public schools in the rural areas should be involved in the oral healthcare schemes, if initiated by the Tamil Nadu Government. Government could use the existing facilities in private practices to extend their service by providing subsidies to improve the access to oral health services both in rural and urban areas.

In Tamil Nadu, the "Chief Minister's Comprehensive Health Insurance" was launched in 2012, aimed at benefiting 134 million families with an annual income of less than INR 72,000 per year (USD 1,100). Individuals and family units may claim medical expenses up to INR 500,000 (USD 8,500) over a five year period (Department of Health and Family Welfare, 2012). This scheme covers 1,016 general health procedures, 113 follow up procedures and 23 diagnostic procedures, but oral health related expenses are not covered. The "Chief Minister's Comprehensive Health Insurance" should be extended to cover oral health expenses.

6.1.1.3 Improving oral health literacy by health professionals

The healthcare system in Tamil Nadu is well established with both national and international recognition, as has been discussed above. Dentists are not able to promote oral health until the public seek oral health services. In the current study, 91% of participants aged 12-15 years old indicated that they had never been to dentist. For this reason, general health professionals, such as GPs, nurses, and healthcare specialists, could take responsibility for improving oral health awareness among the public in the Tamil Nadu region until the oral health services are widely established and respected. Current clinical practice guidelines could be reviewed by the Tamil Nadu Medical Council to implement this strategy. This would mean that health professionals already working in the primary health centres would emphasise the importance of oral health to the parents and adolescents and also point out the link between general health and oral health.

Medical students and all health professions should be educated regarding oral health issues and also the importance of oral health literacy so that they can educate parents and adolescents from an early stage. For this to occur the Directorate of Medical Education, Tamil Nadu, would need to review and strengthen the medical school curriculum to improve oral health literacy education in medical students, which in turn would improve community oral health outcomes.

Doctors, community workers, and health workers, involved in promoting female children/adolescents' health, should inform parents of the importance of feeding female children properly right from the birth so that they have healthy teeth throughout their life. It is well documented that where there has been decay in deciduous teeth there is a higher chance of getting dental caries in permanent teeth (World Health Organisation, 2006). The importance of brushing as soon as the first tooth erupts and having the first dental visit when at one year of age could be promoted by GPs in the urban areas during the vaccination visits, and by the village community health workers in rural areas. This would be the first step in changing the parents' attitude towards their child's oral health. Preventing dental caries in primary teeth is highly important to prevent dental caries in permanent teeth. A risk assessment for acquiring dental caries as an adolescent should be done early with appropriate interventions for children with severe caries in deciduous teeth. The oral health services provided through Primary Health Centres could be reviewed to conduct dental caries risk assessments for primary school students as an early intervention to prevent decay in the permanent teeth. Children who are identified as at high risk could be provided with the fluoride varnish treatments or fluoride tablets. The Tamil Nadu Government should review the current guidelines for the "Oral Health Rural Scheme" so that dental caries risk assessments are undertaken for rural children, especially for females and those from lower caste communities.

6.1.1.4 Creating public attention towards oral health

The availability of free oral health services through primary health centres should be advertised through various means such as television, radio, the Internet (via social networking websites such as Facebook), and newspapers. The rural population's awareness regarding the availability of free oral health services through Primary Health Centres should be researched. In Tamil Nadu, there are 37 television channels available for entertainment and of these 10 channels are especially for children and adolescents. In addition, there are about 60 radio channels that broadcast in the Tamil language, and there are almost 50 different daily newspapers available online. Because the former Tamil Nadu Government gave a free television to every household in the rural parts of Tamil Nadu and also for any house which did not own a television, television is widespread information medium. The current Tamil Nadu Government has provided a free Laptop/computer for every high school student enrolled at a public school to improve the computer literacy.

It would therefore not be unreasonable for policy makers to make use of available media to ensure the new policies reach everyone in the community. A study of the content analysis of children's television food advertisements indicated that 100% were for sugar-rich products especially solid and sticky food (Sukumaran, Diwakar, & Shastry, 2012). This is a further reason why the Government could use popular media to advertise oral health information and improve awareness of the effects of sugar-rich food on oral health. Advertisements and articles across a range of media that related to the effect of eating sugar-rich foods and also the importance of preventing dental decay would reach both the rural and urban population. The educational resources for oral health education could be improved and oral health information could be provided to children/adolescent with the help of famous movie stars. For example, the children's show "Sesame Street" featured famous guest stars such as Michael Jackson and Tom Cruise to educate pre-schoolers on simple life skills. This strategy is well recognised in health promotion theory and in Tamil Nadu, the HIV campaign that began in September 2003, by Population services International for HIV prevention, posed the question *"Pullirajavuku AIDS Varuma?"* (Will Pulli Raja gets AIDS?). This was followed by numerous questions over 3.5 months through posters, newspapers, billboards, and television, which created curiosity among the public and made everyone in Tamil Nadu think and talk about AIDS. The campaign was a so successful (Nair, 2008) in reducing the HIV rates in Tamil Nadu that the campaign was extended to other states of India (Nair, 2008). The Indian Dental Association could spend some of the funding to creating advertisements or short documentaries that is currently allocated to dentists to provide oral health examinations and free toothbrushes and toothpastes. The Government of India's Ministry of Information and Broadcasting and the Tamil Nadu Department of News and Publicity could consider a creative oral health campaign to improve oral health literacy of the community.

6.1.1.5 Improving oral health literacy through school education

Currently, schools are providing some health education through *"Ariviyal Tamil"* (Language science) and "environmental education" which do not cover oral health information. The text books should include oral health information for both primary and higher secondary level. Oral health literacy education should be provided from the pre-school age to improve the attitudes and behaviours toward oral health. This could be achieved by school education using high standard audio visual aids. Currently, the *"Samacheer Kalvi"* (Uniform System of Education) text books do not include oral health information for any class level. Oral health literacy provided in early years would help to improve and to maintain good oral health behaviours and attitudes during the adolescent age. The information such as the structure of the tooth, aetiology of dental caries, brushing techniques, the importance of fluorides, and the effects of sugary snacks and beverages should be added to the *"Samacheer Kalvi"* syllabus. Oral health information would help children/ adolescents to understand the importance of preventing dental caries. Understanding the effect of dental caries would help adolescents to manage dental caries such that they sought help and made use of the already available oral health services to treat dental caries at an early stage.

6.1.1.6 Decreasing the access to sugar-rich food

Sugar was first invented in northern India where the formula for producing sugar crystals was recorded in Sanskrit scripts (Watt, 1893). Currently India is the second largest producer of sugar in the world and Tamil Nadu produces 10% of India's total sugar production. Even though sugar was invented in India, and subsequently introduced to the world by Arab traders, the consumption of processed sugar was low in Indian diet until the late 20th century (Snodgrass, 2004). The westernization in the Tamil Nadu diet has grown with the growth of corporate and multinational industries. The Tamil Nadu Government provides free rice of up to 20 kg per month for lower socioeconomic families and for those who do not want the free rice, or who are not eligible for it can buy ½ kg per head of sugar, and an extra 3 kg for INR13.50 USD0.22) per kg (Civel Supplies and Consumer Production Department, 2014). From this it can be seen that a family of four could get 5 kg of sugar per month which is 60 kg per year for INR810 (USD12): this is equivalent to the cost of just one dental scaling treatment in a private clinic (Civel Supplies and Consumer Production Department, 2014). This policy should be reviewed taking oral health and general health into account. Currently under this policy "*Sakarai Pongal*" (sweet rice) is provided but this could be reviewed by the Department of Social Welfare and Nutritious Meal Programme. The Department of Co-operation, Food and Consumer Protection could establish a policy to decrease sugar intake for both private and public schools with the ultimate aim of establishing a sugar-free lunch policy.

Research should be conducted to understand the impact of providing free and inexpensive sugar on oral health. In addition a nutrition based study should be conducted to understand the average consumption of sugar intake by children, adolescent, youth and adults. In India and in developed countries, sugar consumption could be achieved only by restricting promotions, increasing the price, and by reducing the supply. This would not only improve the oral health but also the general health.

6.1.2 Addressing Oral health Inequality: Gender, Caste and Socioeconomic differences

6.1.2.1 Strengthening the current policies with an oral health focus

Currently, the Tamil Nadu Government's "Rural Health Scheme" includes anaemia diagnosis and treatment for females. Every adolescent girl studying in public schools receives a monthly blood test for anaemia. The "female health scheme" should also include periodic (6 monthly) oral health check-ups to prevent and treat dental caries for the females at an early stage because they are more vulnerable than males.

Dentists and other health professionals should understand their female child/adolescent patient's nutritional status while treating them. Dental students should be educated to understand the gender disparities which occur due to traditions and other cultural reasons, because this is important when treating female children/adolescents. Parents could be made aware of the higher prevalence of dental caries among females and dentists could insist on the need for a healthy diet for female children/adolescents. The current female health promotion campaigns could include the importance of a healthy diet for good oral health.

More oral health policies should be targeted to Scheduled caste and Scheduled tribes in both urban and rural areas and for both private and public schools. Government health schemes should consider improving oral health services to Scheduled Caste and Tribes. The oral health literacy is very low among Scheduled Caste and Tribes population in both rural and urban areas and Most Backward Caste adolescents in rural areas. On this basis, an oral health literacy programme should be implemented to improve their oral health status.

Currently, the objectives of the mid-day meal policy are to increase the gross school enrolment ratio, reduce child mortality and malnutrition, prevent deficiency related diseases, reduce the gender gap, and to eradicate caste discrepancies (Ministry of Human Resource Development, 2013b). Improving oral health should be added as a one of the objectives of mid-day meal policy as this would cover majority of Scheduled Caste and Tribes community child and adolescent population. The policy could be reviewed so that it provides sugar-free and milk for lunch alternatives to enhance children's and adolescents' oral health. Part of this change of policy could involve educating school students about good diet and the impact of sugar on teeth. The free mid-day meal is provided every day including school holidays until the children turn 12 and only on school working days for adolescents (Ministry of Human Resource Development, 2013b). This policy should be reviewed by the Department of Social Welfare and Nutritious Meal Programme to provide the mid-day meal throughout the year even for adolescents, especially for females and Scheduled Caste or Scheduled Tribes population.

In the current study, compared to private school students, public school students were the most affected, and compared to urban schools, rural school students were highly affected by dental caries. Only one private school in the current study offered a free oral check-up conducted by the IDA, in which free toothbrushes and toothpastes were distributed without any oral health examination. Seven schools in rural areas did not have any free oral health check-up. In the current study 91% of participants indicated that they never been to a dentist even though the prevalence of dental caries is 61.5%. The services provided by the IDA are funded through local private dentists, but at present the local dentists tend to choose a school that is close to their own practice or in an urban area for the free oral health camp. This creates an inequity because it means that the services are provided to those in a higher socioeconomic bracket and at private schools, rather than to those already disadvantaged. The free oral health services that the IDA provide should be standardised and target the disadvantaged.

The inequity between rural and urban areas could be redressed by implementing water fluoridation. In Tamil Nadu rural areas, as of April 2013, out of 98,179 habitations (20 families live per habitation), 21,475 habitations partially receive and 76,704 are fully receive water from a communal water supply (Tamil Nadu Water Supply and Drainage Board, 2014). That is, almost 79% of rural areas and almost 100% of urban areas are on a potable water supply. Fluoridating the drinking water would therefore be another option for the Tamil Nadu Government to consider as a means of ensuring better oral health outcomes.

6.1.2.2 Improving the oral health professionals to population ratio

The lower dentist to population ratio and uneven distribution of dental practice between rural and urban areas, with 95% of dentists practicing in urban areas is identified as one of the barriers for improving oral health services in India. This could be addressed by training more dental therapists and oral hygienists. Dental therapist and hygienist courses should be introduced in all dental universities. Currently, only 3000 registered oral hygienists are practicing in India (World Health Organization, 2009). In 1935, New Zealand appointed dental therapists/dental nurses for school dental services and since then 28 countries have followed that lead. Now in New Zealand dental therapists are appointed to provide community dental services. Because it is less expensive to train and to pay the salary for dental therapists than for dentists, introducing dental therapists' courses would help to improve oral health services in rural parts of India and also decrease the cost of appointing dentists to primary health centres. Currently, only 25% of primary health centres in Tamil Nadu have a dental unit and introducing dental therapists who provide free oral health services through the primary health centres and public schools would help to improve oral health outcomes across the community.

The number of places in dental universities of Tamil Nadu for community and public health dentistry is very low and dental universities as well the dental council should consider increasing the number of places for community dentistry. Increasing the number of dental public health professionals would decrease the dental caries by facilitating a major community effort based on oral health promotion.

6.1.3 Recommendations for Researchers

- In the current thesis, only the data for the previous visit to a dentist and filled teeth were available to understand gender disparities. The females had higher oral health literacy scores but also more severe dental caries. This needs further investigation for the Indian context, especially in rural areas. Future studies should be designed to understand the gender disparities that result from cultural reasons and traditions and the impact on oral health. The data on nutritional and other aspects of general health status, combined with qualitative interviews would be required to understand the impact of gender disparities in oral health. Such an understanding will be important for future oral health promotion education and planning.
- The relationship between caste and dental caries is rarely studied in the Indian literature. None of the studies reviewed in the current study had investigated caste as a predictor of dental caries. The current study indicates that the caste categories Scheduled Caste and Tribes are at risk of getting more dental caries because of poor oral health literacy. Future studies should include caste as one of the predictors of dental caries. This will help policy makers to identify at risk groups, tailor oral health promotion messages to such groups and provide more access to oral health services for lower caste populations throughout Tamil Nadu.
- In the current study, the urban school participants were recruited only from 4 schools which could have compromised the random sampling procedure in the current study. In the current study permission to recruit participants was received through individual

schools and the majority of schools in the urban areas did not give permission to recruit participants from their schools. Future research should receive permission from Tamil Nadu Education Department with a list of schools randomly selected, who could then be advised of the study. This process would increase the chances of securing co-operation from public schools, particularly those in urban areas.

- Currently, dental students complete the course required oral health community projects only in and around the places where the university is located. The studies reviewed above for the Tamil Nadu region were conducted in the area where the university is located. Dental students should consider covering different districts of Tamil Nadu, especially rural areas, rather than only doing the projects for the population that is already getting the advantage of the free dental services that are provided by the university. Incentivised programmes may be required to achieve this outcome.

Thesis Recommendations	Tamil Nadu Government
Sugar-Free Lunch, Mid-Day meal throughout the year, Milk for rural Females and SC/ST.	Department of Social Welfare and Nutritious Meal Programme
Oral Health services through PHC, Early caries Risk assessment, Periodic dental check-ups for Females and SC/ST.	Tamil Nadu Health and Family Welfare Department
Strengthening Oral Health Policies to address SC/ST oral health needs.	Department of Adi Dravidar and Tribal Welfare
Controlling the availability of Sugar to the communities. Improving supply of milk and milk products.	Department of Co-operation, Food and Consumer Protection
Considering Water Fluoridation and encouraging more research on adopting water fluoridation throughout TN.	Tamil Nadu Water Supply and Drainage
Reviewing "Samacheer Kalvi" curriculum to improve Oral health Literacy Education	Department of school Education
Decreasing dropout ratio in higher secondary and increasing females enrolment in university education.	Department of Higher Education
Increasing number of places in dental hygienists and dental public health courses. Introducing dental therapist course.	Tamil Nadu Dental Council

Figure 34 Recommendations to Tamil Nadu Government Departments to consider

6.2 Strengths and Limitations of the Study

6.2.1 Strengths

- The current study is the first study to determine the association between oral health literacy and dental caries in an adolescent population.
- The sample size is one of the major strengths of the study. It was carefully calculated for the statistical analysis needed to address the research questions. Hence this was an adequately powered study to identify the expected results.

- The developed oral health literacy questionnaire has good internal reliability which increases the strength and reliability of the reported findings.
- The oral health examination was conducted by following the standard WHO oral health survey protocol, as provided in the WHO survey manual.
- Participants were recruited from both private and public schools in rural and urban areas of Tamil Nadu and this gives a picture of the oral health status in different types of adolescent population in Tamil Nadu. The current study is the first study in Tamil Nadu which involved both private and public school participants in both rural and urban areas of two districts in Tamil Nadu.
- This research would appear to be the first in India which identifies the difference in prevalence and severity of dental caries in different castes.

6.2.2 Limitations

- The urban participants were recruited from 4 schools rather than the proposed sample of 8 schools because of issues in obtaining permission from the schools. Recruiting participants from the sample of 8 schools, as proposed, would have covered majority of suburbs in Chennai city and would have provided a truly representative sample of the total adolescent population in Chennai.
- In India, male children/adolescents are usually considered as more important for the family and daughters get less access to nutritious food when compared to sons. In the current study, the differences in dental caries prevalence and severity between females and males were expected, but enough data regarding food intake was not available to investigate the reason behind more DMFT in females despite the fact they had more oral health literacy skills. This relationship should be further investigated in future studies.

- The majority of participants who reported that they did not know their parents' level of education also had more dental caries. Limited information was collected to give an explanation for this association as reported in the current study. It was assumed that these parents are illiterate and that the participants did not want to report this sensitive information. Future studies should be more carefully designed to better collect parental educational status because there is a high correlation between parents' educational attainment and adolescents' oral health literacy/oral health status.
- The prevalence of dental caries in the Forward Caste was lower than all other communities but the severity of dental caries for the Forward Caste is higher than the for the Backward Caste participants. This result might be because of the nature of vegetarian diet that is followed by the Forward Caste and data on diet was not collected in this study, and therefore this relationship needs further investigation. Future studies could collect information on diet to address this limitation.

6.5 Conclusions

In this section, first, the conclusions for the results of the questions posed in the thesis are discussed. Second, the questions that have arisen from the current thesis that could form the basis for future research and the policy making are presented. The final section provides a more general conclusion for a wider audience.

6.5.1 Questions Answered by the Thesis

This thesis posed the questions:

- What is the prevalence and severity of dental caries?
- What is the level of oral health literacy among adolescents attending private and public schools in the rural and urban areas of Tamil Nadu, India?
- What is the association between oral health literacy and dental caries?

The research questions were addressed using a cross-sectional descriptive correlational quantitative study and data were collected through an oral health examination to measure dental caries status and a self-administered questionnaire survey to understand the level of oral health literacy among 974 school students aged 12-15 years.

6.4.1.1 Dental caries status among Tamil Nadu Adolescents

The DMFT index was measured using oral health survey data and later the prevalence and severity of dental caries were measured using statistical analyses. The prevalence of dental caries was identified for the total sample as 61.4% and the average total DMFT score, which was calculated as 2.03. The prevalence and severity of dental caries were almost equivalent to most of the developed countries except for Australia and New Zealand. When compared to other studies conducted in Tamil Nadu, the prevalence of caries was lower than had been reported for studies conducted before 2005 but the severity of dental caries had increased. This may be because of an inequity in the delivery of services. The DMFT reported in rural areas is higher than in the urban area and the results are consistent with other recent studies. The distribution of both private and Government Dental University hospitals which provide a free or inexpensive, dental treatments are clustered in the urban areas. In addition the dental units are only available to 25% of primary health centres in rural areas. The prevalence of caries might be controlled after the 2008 policy on free rural oral health scheme in 360 primary health centres. The unavailability of oral health services to 75% of primary health centres in rural areas is the most likely the reason for the increase in the severity of the disease in those who already had the disease. For this reason, policies could be focused more on improving access to oral health services in rural areas throughout Tamil Nadu.

6.4.1.1 Level of Oral Health Literacy skills among Tamil Nadu Adolescents

The level of oral health literacy skills was poor among 35% of participants and only 8.3% of participants were identified having a sufficiently good level of oral health literacy to prevent and manage dental caries. In the current study, 95% participants indicated that they had never been to the dentist and the current Tamil Nadu school curriculum does not have an oral health education component which explains the reasons for the very minimal number (8.3%) of participants that have good oral health literacy skills. The availability of oral health information for Tamil Nadu adolescents could be described, at present, as minimal. There is very limited oral health information on Tamil Nadu televisions, even though, as discussed above, this medium is popular among children and adolescents. Because of this, an oral health literacy intervention through the schools and all other possible means, such as television, radio, newspaper, posters, the Internet, and hospital pamphlets could be enhanced to improve oral health literacy skills. The current "*Samacheer Kalvi*" (Uniform system of education) curriculum does not have an oral health education component and the curriculum could be updated to include oral health literacy education at both in primary and secondary levels. The oral health literacy skills of adolescents in countries who have oral health education implemented already in the school curriculum could be researched to understand the effect of school oral health literacy education on adolescents' oral health.

6.4.1.1 Oral Health Literacy and Dental caries among different Sociodemographic variables

Bivariate and multiple regression analyses were performed to understand the distribution of dental caries and oral health literacy skills among different socioeconomic categories such as gender, age, parent's education, type of school, location of the school, and the caste categories. The bivariate analyses indicated statistically significant associations for all sociodemographic variables (SDV) when analysed separately for dental caries and oral health literacy. Multiple regression analyses were conducted for prevalence of dental caries and SDV, severity of dental caries and SDV, oral health literacy and SDV, and finally for dental caries and oral health literacy by controlling for all SDV.

The multiple logistic regression analysis indicated that the adolescents attending public schools and community categories (Forward Caste, Scheduled Caste/Scheduled Tribes and Most Backward Caste) were strong predictors of the prevalence of dental caries when controlling for gender, age, parent's education, location of school and type of school. The multiple linear regression analysis using sociodemographic variables as predictors of the total DMFT score identified the categories of gender, Scheduled Caste, Most Backward Caste, mother's education less than 12th standard and university level as the strongest predictors of severity of dental caries. The multiple linear regression analysis with total oral health scores indicated that the mother's education at university level, gender and Scheduled caste and

Scheduled tribes as a significant predictors of oral health literacy skills. When the sample is split into rural and urban groups, the females and Most Backward Caste in rural areas had more dental caries and poor oral health literacy compared to other categories. Adolescents from the community categories, Scheduled caste/ Scheduled tribes demonstrated a poor oral health and oral health literacy skills in both rural and urban areas.

Taken together the results of the multiple regression analyses results indicate a consistent pattern which is illustrated in Figure 35. Figure 35 shows that the adolescents in the categories who had lower oral health literacy skills had a higher prevalence and severity of dental caries. This pattern reveals that oral health policies and oral health literacy interventions could be more concentrated on females, Scheduled Caste/ Tribes and Most Backward population in rural areas to improve the overall oral health outcome in Tamil Nadu.

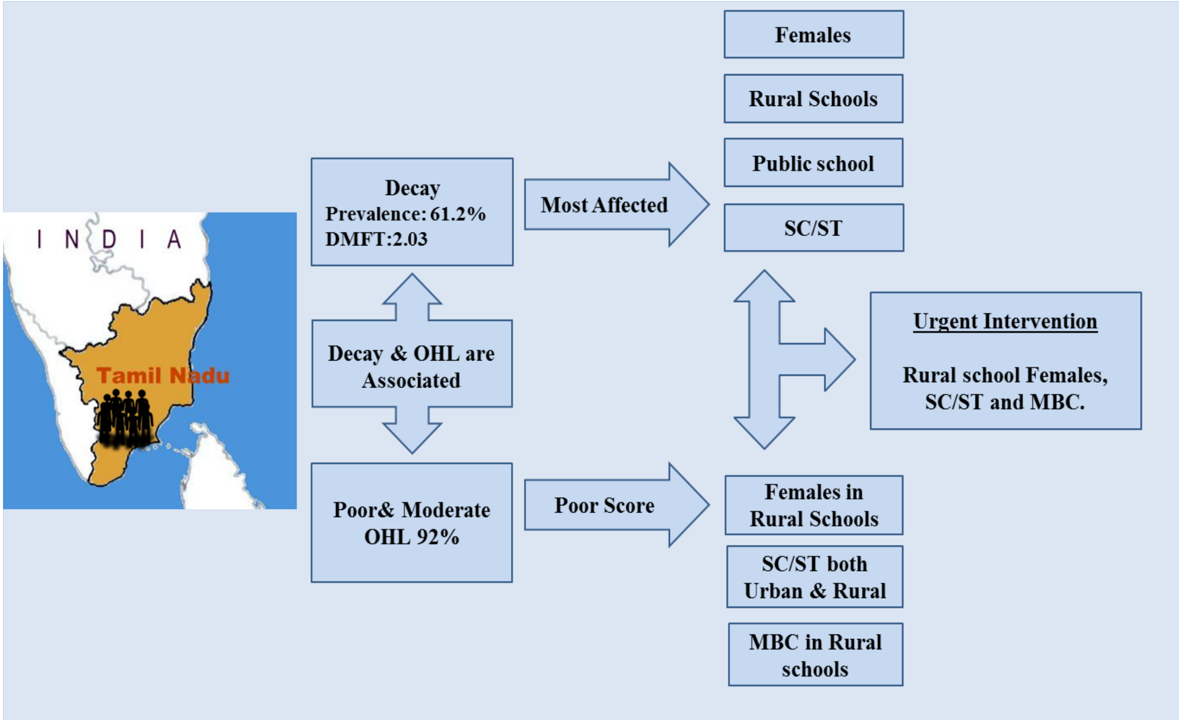

Figure 35: Summary of Conclusions

6.4.2 Questions Raised by the Thesis

6.4.2.1 Do females need more oral health literacy skills than males to attain the same level of oral health status?

A statistically significant negative association was identified between oral health literacy skills and DMFT scores for the total sample and also when the sample was split into male and female cases. Unexpectedly, the females had good oral health literacy skills when compared to males, but the prevalence and severity of dental caries were higher for the females. This result indicates that the level of oral health literacy skills expected to achieve good oral health in females might need to be even higher when compared to males. Earlier studies reported that oral health literacy in females of all ages as being higher than males, but there is a need for females to have even higher oral health literacy skills than their male counterparts so that they can manage their oral health. This has not been discussed either in international or Indian literature. The association between females having poor teeth and yet good oral health literacy skills (compared to males) is first reported in this study. A female's oral health is compromised because of the nature of tooth anatomy and various hormonal issues. A unique contributing issue for females in India is a cultural one: sons/males are considered as being more important, with the consequence that the female child in the family, even from the birth, does not receive as much nutritious food. This increases the burden on female oral health. These factors together might demand a higher level of oral health literacy skills in females so that they can attain a similar oral health status to that reported for male peers. This result needs further investigation to understand whether a gender consideration is needed in developing and measuring the oral health literacy instrument, and in designing any oral health literacy intervention.

6.4.2.2 Does culture influenced gender disparities, a reason behind the compromised oral health among females in rural areas of Tamil Nadu?

In the current study, females in rural areas have poor oral health when compared to females in urban areas, and poor oral health compared to males in both urban and rural areas. While earlier research (both international and Indian) and also the current research (total sample) suggest females have higher oral health literacy when compared to males, the current research shows that females living in rural areas of Tamil Nadu had poor oral health literacy skills as well as higher dental caries. The difference between rural and urban females might be the differences in availability of nutritious food, the parents' level of education and a greater access to oral healthcare in urban areas. Further research is needed to identify the reasons behind the impact of culturally induced gender disparities on oral health in rural areas of Tamil Nadu.

6.4.2.3 Is there any reason, other than lower economic status and poor oral health literacy for poor oral health in the lower caste population in Tamil Nadu?

The current study is first to show that community/caste is one of the major significant predictors of dental caries and the level of oral health literacy. The lower caste categories, such as the Scheduled caste and Scheduled tribes were identified as the vulnerable population in both rural and urban areas attending both private and public schools. The Most Backward Caste participants in rural schools have more severe dental caries when compared to Most Backward Caste in urban schools. Oral health literacy skills were reported as lower among the Scheduled Caste and Tribes population. Irrespective of where they live, or which school they go, the Scheduled Caste and Tribes had poor oral health literacy and oral health status. Further research is needed to identify why the adolescents who belong to the Scheduled Caste and Tribes had poor oral health literacy and higher dental caries, even when they attended a private school in the urban areas of Tamil Nadu. Genetic, nutritional, environmental and cultural reasons could be investigated.

6.4.3 General Conclusion

The current study results show that the prevalence of dental caries among adolescents in Tamil Nadu decreased after the introduction of dental units in primary health centres in rural areas. In contrast, however, the severity of dental caries increased when compared to other recent studies conducted in Tamil Nadu. This result suggests either a less than universal delivery or a less than universal uptake of free oral health services provided in Tamil Nadu, either of which requires further investigation. Currently, only 25% of primary health centres have dental units and improving the access to oral health services through primary health centres in rural areas throughout the state of Tamil Nadu is necessary to improve the overall oral health literacy and oral health status. Improving access to oral health services not only improves the oral health outcome in the community but it also increases the oral health literacy among the population.

This research has identified two groups in Tamil Nadu as “at risk” populations that are likely to be most affected by dental caries because of their poor oral health literacy skills: those who attend public schools in rural areas and who are either females (child and adolescent), and/or children/adolescents who are a member of a Scheduled Caste or Scheduled Tribes community. Oral health policies and oral health literacy interventions should be targeted to these adolescent populations in Tamil Nadu and free access to oral health services strengthened so that females and the Scheduled caste and Scheduled tribes have improved oral health outcomes.

7. References

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Appendix A: Permission Letter for Table 1

RE: Permission to use Table in Thesis

Sorensen Kristine (INTHEALTH) [k.sorensen@maastrichtuniversity.nl]
Sent: Tuesday, July 07, 2015 6:48 PM
To: Arthi Veerasamy

Dear Arthi Veerasamy

Thank you for applying my research in your PhD study. You are welcome to use the Table 1 from the article Health Literacy and Public Health: A systemic review and integration of definitions and models from the BMC Public Health.

I wish you success in finishing the PhD!

Kind regards

Kristine Sorensen

From: Arthi Veerasamy [mailto:arthi.veerasamy@pg.canterbury.ac.nz]
Sent: dinsdag 7 juli 2015 3:08
To: Sorensen Kristine (INTHEALTH)
Subject: Permission to use Table in Thesis

Dear Dr Kristine Sorensen,

I am currently studying PhD in University of Canterbury, New Zealand. My topic is 'Epidemiology of dental caries and level of Oral health literacy in adolescents in Tamil Nadu'.

I would like your permission to use the "Table: 1" published on BMC public Health in the article titled 'Health literacy and Public health: A systemic review and integration of definitions and models'.

I would like to present the table with a proper credentials by referencing both in the table legend and as an in-text citation on every mention. Please consider my e-mail and give your permission. Thank you.

With Regards

Arthi Veerasamy

University of Canterbury

Appendix B: The Selection of the Study Districts in Tamil Nadu, India.

Appendix C: Permission to reproduce or reprint WHO materials

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permissions <permissions@who.int> May 19

to me

Dear Arthi,

Thank you for your interest in WHO publications.

If you wish to use the extract for research, private study or in a noncommercial document with limited circulation (such as an academic thesis or dissertation), you may do so without seeking permission. Our only requirement is that the WHO source should be appropriately acknowledged. (Example Source: © World Health Organization, TITLE, YEAR)

Should you have further questions, please do not hesitate to ask.

Kind regards,
Joelle Jacquier
WHO Press

Appendix D: Permission to reproduce Map in figure 12

Permission to use figure

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Arthi Veerasamy 20 hours ago

Dear Sir,
I am currently doing PhD in University of Canterbury, New Zealand on the topic Epidemiology of Dental caries in Adolescent in Tamil Nadu, India. I would like your permission to use a figure in one of your articles titled " Epidemiology of dental caries in the world; Figure 5, Page 154. It would be more helpful for me to present the figure in my thesis in literature review section. Sorry, your e-mail was not given in the article and I had to use this space to contact you. Thanks in advance.
With Regards
Arthi Veerasamy
e-mail id: arthisen3@gmail.com

Rafael Moreira to you 20 hours ago

Dear Arthi, thank you for your consideration to use the figure. There is no problem but it is necessary to explicit the reference source.
Kind Regards,
Rafael Moreira
e-mail: moreirars@cpqam.fiocruz.br

Appendix E: Pilot Survey Questionnaire

Part 1: About yourself

Write your code number given during the oral examination and tick the box for boy or girl.

Code number [| | |] Boy Girl

Please circle the number next to the answer you want to give.

1. How old are you?

   12 years or below——————————— 1

   13 years————————————— 2

   14 years————————————— 3

   15 years—————————————4

   16 years or above ——————— — 5

[| | |]

2. What was the highest level of education your father (step-father or male guardian) completed?

   8th standard or less ——————————- 1

   10th standard ——————————— 2

   12th standard ———————————3

   Completed college ————————4

   No father or step father or

   male guardian living with me————— 5

   Don't Know ——————————— 6

வாய்நல அறிவு வினாவிடை புத்தகம் /2012

பல் மருத்துவர் உனது வாயை ஆய்வு செய்த போது வழங்கிய குறியீட்டு எண்ணை கீழே எழுதவும். ஆணா பெண்ணா என்பதை கட்டத்தில் டிக் செய்யுவும்.

குறியீட்டு எண் ஆண் பெண்

பின்வரும் வினாக்கள் ஒவ்வொன்றிக்கும் பதிலை அதற்கு அருகில் உள்ள எண்ணை வட்டமிடுதல் மூலம் தெரிவிக்கவும்.

1. உனது வயது என்ன?

12 ஆண்டு / அதற்கு கீழ் 1

13 ஆண்டு 2

14 ஆண்டு 3

15 ஆண்டு 4

16 ஆண்டு/ அதற்கு மேல் 5

2. உனது தந்தையின் (அல்லது ஒன்று விட்ட தந்தை/ ஆண் பாதுகாவலர்) படிப்பறிவு என்ன?

8– ஆம் வகுப்பு/ அதற்கு குறைவாக 1

10– ம் வகுப்பு 2

12–ம் வகுப்பு 3

கல்லூரிக் கல்வி முடித்தவர் 4

மேற்குறிப்பிட்டது ஏதுமில்லை 5

தெரியாது 6

3. What was the highest level of education your mother (step-mother or female guardian) completed?

8th standard or less ———————— 1

10th standard ——————————2

12th standard ——————————3

Completed college ————————4

No father or step father or

female guardian living with me———— 5

Don't Know ———————————6

4. How long have you been at this school?

Less than 1 year————————1

1-2 years ——————————— 2

More than 2 and up to 3 years ———— 3

More than 3 and up to 4 years ———— 4

More than 4 and up to 5 years ———— 5

More than 5 years ———————6

5. What kind of work does your father (step-father or male guardian) do?

Write your answer here: ____________________________

6. What kind of work does your mother (step-mother or female) do?

Write your answer here: ____________________________

3. உனது தாயின் (அல்லது ஒன்று விட்ட தாய்/ பெண் பாதுகாவலர்) படிப்பறிவு என்ன?

8–ம் வகுப்பு / அதற்கு குறைவாக	1
10–ம் வகுப்பு	2
12–ம் வகுப்பு	3
கல்லூரிக் கல்வி முடித்தவர்	4
மேற்குறிப்பிட்டது ஏதுமில்லை	5
தெரியாது	6

4. இப்பள்ளியில் கற்ற ஆண்டுகள் எத்தனை?

1– ஆண்டிற்கு கீழ்	1
1–2 ஆண்டுகள்	2
2–3 ஆண்டுகள்	3
3–4 ஆண்டுகள்	4
4–5 ஆண்டுகள்	5
5 ஆண்டுகளுக்கு மேல்	6

5. உனது தந்தை என்ன பணி செய்கிறார்?

____

6. உனது தாய் என்ன பணி செய்கிறார்?

____

7. Are you.....

Forward class———————————1

Backward class ——————————2

Most backward class ————————3

Other class ————————————4

Don't know ———————-————-5

Part 2: Oral health knowledge

8. A cavity is:

silver filling -———————————— 1

a small hole in a tooth ———————— 2

sticky coating on the tooth ——————— 3

don't Know —————————-——— 4

9. Plaque is:

left-over food on the teeth———————— 1

a cavity————————————————2

a sticky film that forms on teeth—————— 3

don't know—————-——————————- 4

7. எந்த இனத்தை சார்ந்தவர்?

முற்பட்ட வகுப்பு 1

பிற்பட்ட வகுப்பு 2

மிக பிற்பட்ட வகுப்பு 3

மற்றவை 4

தெரியாது 5

8. பல்லில் தோன்றும் கேவிட்டி என்றால் என்ன?

வெள்ளி அடைப்பு 1

பல்லில் சிறிய துளை 2

பல்லில் படிந்த பொருள் 3

தெரியாது 4

9. பற்காறை என்றால் என்ன?

பற்களுக்களுக்கு இடையில் சிக்கி உள்ள உணவுத் துண்டு 1

பற்குழி 2

பற்களில் மேல் படிந்த பொருள் 3

தெரியாது 4

10. Tooth enamel is:

the hard outer layer of a tooth—————————- 1

a cavity——————————————————— 2

the inside of a tooth——————————————3

don't know————————————————— 4

11. Eating sugary snacks between meals:

is not rally harmful to your teeth———————--1

helps your teeth to grow—————————————-2

can cause cavities in your teeth—————————3

don't know——————————————————4

12. Children should see a dentist:

Every 6 months———————————————— 1

Once in 2 years———————————————— 2

Only if there is any pain in their tooth———— 3

Don't know——————————————————4

10 பல் எனாமல் என்றால் என்ன?

பல்லின் கடினமான மேற்பாகம் 1

பற்குழி 2

பல்லின் உட்பகுதி 3

தெரியாது 4

11. இரு உணவுகளுக்கு இடைப்பட்ட காலத்தில் இனிப்புகள் உண்பதன் விளைவு என்ன?

பற்கள் கெடா 1

பற்கள் வளரும் 2

பற்களில் துளை ஏற்படும் 3

தெரியாது 4

12. பல் மருத்துவரை குழந்தைகள் எத்தனை முறை பார்க்க வேண்டும்?

6– மாதங்களுக்கு ஒருமுறை 1

2– ஆண்டுகளுக்கு ஒருமுறை 2

பற்களில் வலி வரும் போது 3

தெரியாது 4

13. One of the important ingredients in a toothpaste is

Fluoride————————————————————1

Chloride————————————————————2

Sugar————————————————————3

Don't know———————————————————— 4

14. How to clean inter-dental areas (between two teeth)?

Tooth brush————————————————1

Floss————————————————2

No need to clean between two teeth—————- 3

Don't Know ———————————————— 4

Part 3: oral health attitudes and behaviour

15. How often do you clean your teeth?

Never————————————————————1

2-3 times a day————————————————2

Once a week————————————————3

2-6 times a week————————————————4

Once a day———————————————— 5

2 or more times a day———————————————— 6

13. பற்பசையில் உள்ள முக்கிய பொருட்களில் ஒன்று யாது?

புளூரைடு	1
குளோரைடு	2
சர்க்கரை	3
தெரியாது	4

14. பற்களுக்கு இடைப்பட்ட பகுதியை சுத்தம் செய்வது எவ்வாறு?

பல்தேய்க்கும் பிரஷ் கொண்டு	1
நூல் (பிளாஷ்) கொண்டு	2
இடைவெளிகளை சுத்தம் செய்வதில்லை	3
தெரியாது	4

Part 3:

15. எப்போதெல்லாம் பல் தேய்ப்பீர் ?

தேய்ப்பதில்லை	1
வாரம் ஒருமுறை	2
வாரம் 2– லிருந்து 6 முறை	3
தினம் ஒரு முறை	4
தினம் 2 அல்லது அதற்கு மேற்பட்ட முறை	5

1. Do you use any of the following to clean your teeth or gums?

Please tick the box for the answer that you want to give.

	No	**Yes**
Toothpaste ————————		
Toothbrush————————		
Wooden toothpicks——————		
Plastic toothpicks———————		
Thread (Dental floss) —————		
Charcoal—————————		
Chew stick / miswak—————		
Tongue Cleaner———————		
Other——————————		

16. பின்வருவனவற்றில் எவற்றைக் கொண்டு பற்கள், ஈறுகளை சுத்தம் செய்கிறாய்? (ஒவ்வொரு பதிலுக்கும் வட்டமிடு)

வகை	ஆம்	இல்லை
பற்பசை	ஆம்	இல்லை
பல் தேய்க்கும் பிரஷ்	ஆம்	இல்லை
மரத்தாலான பல்குத்தி	ஆம்	இல்லை
பிளாஸ்டிக் பல்குத்தி	ஆம்	இல்லை
நூல் (பல் பிளாஷ்)	ஆம்	இல்லை
கரி	ஆம்	இல்லை
பல் தேய்க்கும் குச்சி	ஆம்	இல்லை
நாக்கு வழிப்பான்	ஆம்	இல்லை

வேறு ஏதேனும் இருப்பின் கீழே குறிப்பிடவும்.

17. How often do you eat or drink any of the following foods, even in small quantities?
Please tick the box for the answer that you want to give.

Food(Read each item)	Several times a day	every-day	Several times a week	Once a week	Several times a month	Never
Fresh fruit						
Biscuits, cakes, wafers, buns, brad etc						
Lemonade, Mango shakes, Cola, other soft drinks						
Jam, honey						
Chewing gum containing sugars						
Sweets, candy, burfy, gajak etc						
Milk with sugar						
Tea with sugar						

17. பின்வருவனவற்றை எவ்வாறு உண்ணுவீர்? (சிறிதளவாக இருப்பினும் பதிலை உரிய இடத்தில் டிக் செய்யவும்

உணவுவகை	தினம் பல முறை	தினம் ஒரு முறை	வாரம் பல முறை	வாரம் ஒரு முறை	மாதம் பல முறை	மாதம் ஒரு முறை
பழம்						
பிஸ்கட், கேக்வேபர், பன், பிரட்						
எலுமிச்சை, மாம்பழச்சாறு,கோலா போன்ற குளிர் பானங்கள்						
ஜாம். தேன்						
சூவிங்கம்						
இனிப்புகள் மிட்டாய், பர்பி போன்றவை						
சர்க்கரை சேர்த்த பால்						
சர்க்கரை சேர்த்த தேநீர்						

18. How often do you use any of the following types of tobacco? **Please tick the box for the answer that you want to give**

ch item)	every-day	Several times a week	Once a week	Several times a month	Seldom	Never
igarettes, igars						
wing tobacco						

ளாம் புகையிலைப் பொருட்கள் பயன்படுத்துகிறாய்? டிக் செய்யவும்

Part 4: oral health prevention

Please circle the number next to the answer you want to give

19. How would you describe the health of your teeth and gums?

Excellent——————————————————1

Very good—————————————————2

Good———————————————————3

Average—————————————————— 4

Poor——————————————————— 5

Very poor————————————————— 6

Don't Know———————————————— 7

19 உனது பல் மற்றும் ஈறுகள் எந்நிலையில் உள்ளன?

மிகமிக நன்று 1

மிக நன்று 2

நன்று 3

சுமார் 4

மோசம் 5

மிக மோசம் 6

20. Do you have tooth decay?

Yes———————————————————1

No———————————————————2

Don't Know————————————————3

21. How do you know that you have tooth decay?

My parent told me——————————1

My friend told me——————————2

My dentist told me——————————3

My doctor told me——————————4

I found it myself——————————5

I don't have tooth decay—————— 6

22. If you have any doubts about your tooth or gums, what will you do?

Ask my father (step-father or male guardian) ———— 1

Ask my mother (Step-mother or female guardian) ——— 2

Ask my friends—————————————— 3

Ask my siblings (brother or sister) -—————4

Ask my teacher ————————————— 5

Others, if any, please write them here _______________

20. உனது பற்கள் சொத்தையாக இருக்கின்றனவா?

ஆம் 1

இல்லை 2

தெரியாது 3

21. உனது பற்கள் சொத்தையாகி விட்டன என்று எவ்வாறு அறிவாய்?

(ஒன்றிற்கும் மேற்பட்ட பதில்கள் அளிக்கலாம்)

பெற்றோர் மூலம் 1

நண்பன் மூலம் 2

பல்மருத்துவர் கூறினார் 3

பொது மருத்துவர் கூறினார் 4

நானே தெரித்து கொண்டேன் 5

பற்கள் கெடவில்லை 6

22. பற்கள் ஈறுகள் பற்றி சந்தேகம் இருப்பின் என்ன செய்வாய்?

(தேவைப்பட்டால் ஒன்றிற்கும் மேற்பட்ட பதில்கள் தரலாம்)

தந்தையை விசாரிப்பேன் 1

தாயை விசாரிப்பேன் 2

நண்பனை கேட்பேன் 3

சகோதரர்களை விசாரிப்பேன் 4

ஆசிரியரிடம் விசாரிப்பேன் 5

வேறு வழி இருப்பின் கீழே குறிப்பிடவும்

23. If something got stuck between your teeth, what will you do?

Use brush to remove———————————— 1

Use tooth pick to remove——————————- 2

I don't do anything————————————— 3

Use floss to remove————————————— 4

Use bobby pin or smoothing sharp to remove—— 5

Food never stuck between my teeth—————— 6

Others, if any, please write them here ____________

23. பற்களுக்கு இடையே ஏதேனும் சிக்கினால் என்ன செய்வாய்?

பிரஷால் எடுப்பேன் 1

பல்குத்தியால் எடுப்பேன் 2

ஏதும் செய்யமாட்டேன் 3

நூல் (பிளாஷ்) பயன்படுத்துவேன் 4

ஊசி போன்ற கூரான கருவியால் எடுப்பேன் 5

உணவுத் துண்டுகள் சிக்கியது கிடையாது 6

வேறு ஏதேனும் வழி இருப்பின் கீழே எழுதவும்.

24. Circle yes or no for each statement below	Y	N
A person should make time to see the dentist at least once a year.		
It is my job to clean my teeth everyday to have a nice smile.		
Brushing our teeth two times a day is not important.		
It is normal to get decay or tooth ache.I would like to know more about my teeth and brushing.		
No one ever talk to me about teeth and brushing.		

24. பின்வரும் கூற்று ஒவ்வொன்றிற்கும் ஆம் அல்லது இல்லை என்று பதிலளிக்கவும். ஆம் (ஆ) அல்லது இல்லை (இ) என்பதை வட்டமிடு.

ஆண்டிற்கு ஒருமுறை பல்மருத்துவரை பார்ப்பேன் ஆ / இ

ஒவ்வொரு நாளும் பற்களை சுத்தம் செய்வேன் ஆ / இ

தினம் இருமுறை பல்தேய்ப்பது முக்கியமில்லை ஆ / இ

பல்வலி, பல் சொத்தை இயல்பானதே ஆ / இ

பற்கள், அவற்றின் சொத்தை பற்றி மேலும் அறிய

விரும்புகிறேன் ஆ / இ

பற்கள் அவற்றின் சொத்தை பற்றி யாரும்

என்னிடம் பேசியதில்லை ஆ / இ

Part 5: Comprehensive knowledge

Instructions: This is a story about a boy named Kumar. The story will help you to answer some questions. If you need help, please ask.

Kumar went to the dental clinic for a tooth extraction (remove) due to decay in his tooth. Dentist removed his tooth and instructed Kumar to bite the cotton for one hour and not to eat solid food for one hour. Dentist asked him not to spit or drink anything using straw for 24 hours. Dentist gave him 15 tablets and asked him to take medicine three times a day after food.

Please use the information in the passage to choose whether the statement is true or false.

Circle True or False for each statement:

27. Kumar has to bite the cotton for one hour.	T	F
28. It is okay to eat a biscuit 30 minutes after the extraction	T	F
29. Kumar has to take medicine for three days.	T	F
30. Kumar has to spit the cotton after one hour.	T	F
31. Kumar's tooth was removed due to the decay.	T	F

Thank you for completing this survey. Your help is much appreciated. Once you are finished please return your questionnaire to the researcher who will collect them from you.

குறிப்பு : குமார் என்ற சிறுவனைப் பற்றிய கதை கீழே தரப்பட்டுள்ளது கதையைப் படித்து சில வினாக்களுக்கு பதில் அளிக்கவும். (உதவி வேண்டும் எனில் கேட்டுப் பெறவும்)

பற்கள் சொத்தையானதால் குமார் பல்மருத்துவரை அணுகினார். கெட்ட பல்லை பிடுங்கிவிட வேண்டினார். மருத்துவர் சொத்தையான பல்லை எடுத்துவிட்டார். அந்த இடத்தில் பஞ்சை வைத்து ஒரு மணி நேரம் கடித்துக் கொண்டிருக்ககுமாறு கூறினார். ஒரு மணி நேரத்திற்கு திட உணவு உட்கொள்ள வேண்டாம் என்றார். மேலும் 24 மணி நேரத்திற்கு துப்ப வேண்டாம்; ஸ்டிரா கொண்டு எதுவும் குடிக்க வேண்டாம் என்று அறிவுறுத்தினார். அவர் 15 மாத்திரைகளை கொடுத்தார். தினம் மூன்று முறை உணவுக்குப்பின் ஒரு மாத்திரை எடுக்குமாறு கூறினார்.

இக்கதையைப் படித்து பின்வரும் கூற்றுகள் சரியா தவறா என் வட்டமிட்டு காட்டுக.

27. குமார் ஒரு மணி நேரம் பஞ்சை கடித்துக் கொண்டிருப்பது அவசியம். சரி/ தவறு

28. முப்பது நிமிடங்களுக்கு பிறகு பிஸ்கட் உண்பது சரிதான். சரி/ தவறு

29. மூன்று நாட்களுக்கு மட்டும் குமார் மருந்து உட்கொள்ள வேண்டும். சரி/ தவறு

30. ஒரு மணி நேரத்திற்கு பிறகு பஞ்சை துப்ப வேண்டும் சரி/ தவறா

31. சொத்தை யானதால் குமாரின் பல் பிடுக்கப்பட்டது. சரி/ தவறு.

விபரங்கள் அளித்தமைக்கு நன்றி. உதவிக்கு மிகுந்த பாராட்டுகள். பதிலளித்தவுடன் வினா–விடை புத்தகத்தை ஆய்வாளரிடம் ஒப்படைக்கவும்.

Appendix F: Oral Health Literacy Quetionnaire (English Version)

Questions like these, about dental care and your teeth, are being asked of students your age in parts of Tamil Nadu. The purpose of this study is to gather information about the ways dental health might be improved.

Instructions

This is not the test. However, it is important that you **answer all the questions.** The answers you give will help us provide good dental care to children in Tamil Nadu. **There is no correct or wrong answer.**
Read all the instructions carefully and answer each question as best you can. Read each question carefully; give us your answer or opinion and then go on to the next question. If you do not understand the instructions or puzzled about a particular question, raise your hand and I will come to your desk to help you.
Write your code number given during the oral examination and tick the box for boy or girl.

Code number ☐☐☐☐ Boy ☐ Girl ☐

Please circle the answer you want to give.

1. How old are you?
   a) 12 years or below
   b) 13 years
   c) 14 years
   d) 15 years
   e) 16 years or above

2. What was the highest level of education your father (step-father or male guardian) completed?
   a) 8^{th} standard or less
   b) 10^{th} standard
   c) 12^{th} standard
   d) Completed college
   e) No father or step father or male guardian living with me
   f) Don't Know

3. What was the highest level of education your mother (step-mother or female guardian) completed?
   a) 8^{th} standard or less
   b) 10^{th} standard
   c) 12^{th} standard
   d) Completed college
   e) No mother or step mother or female guardian living with me
   f) Don't Know

4. What kind of work does your father (step-father or male guardian) do?
   Write your answer here: _____________________________

5. What kind of work does your mother (step-mother or female) do?
   Write your answer here: _____________________________

6. Are you.....
   a) Forward caste (FC/OC)
   b) Backward caste (BC)

c) Most backward caste (MBC)
d) Scheduled Caste (SC)
e) Scheduled tribes (ST)
f) Don't know

7. A cavity is:
    a) silver filling
    b) a small hole in a tooth
    c) sticky coating on the tooth
    d) don't Know

8. Plaque is:
    a) left-over food on the teeth
    b) a cavity
    c) a sticky film that forms on teeth
    d) don't know

9. Tooth enamel is:
    a) the hard outer layer of a tooth
    b) a cavity
    c) the inside of a tooth
    d) don't know

10. Eating sugary snacks between meals:
    a) is not really harmful to your teeth
    b) helps your teeth to grow
    c) can cause cavities in your teeth
    d) don't know

11. Children should see a dentist:
    a) Every 6 months
    b) Once in 2 years
    c) Only if there is any pain in their tooth
    d) Don't know

12. One of the important ingredients in a toothpaste is
    a) Fluoride
    b) Chloride
    c) Sugar
    d) Don't know

13. How to clean inter-dental areas (between two teeth)?
    a) Tooth brush
    b) Floss
    c) No need to clean between two teeth
    d) Don't Know

14. How often do you clean your teeth?
    a) Never
    b) 2-3 times a day
    c) Once a week

d) 2-6 times a week
e) Once a day
f) 2 or more times a day

Do you use any of the following to clean your teeth or gums? **Please tick the box for the answer that you want to give.**

Q.No	Item	Everyday	Several times a week	Once a month	Several times a month	Never
15	Toothpaste					
16	Toothbrush					
17	Wooden toothpicks					
18	Thread (Dental Floss)					
19	Charcoal					
20	Chew stick/Neem stick					
21	Tongue Cleaner					

Others____

How often do you eat or drink any of the following foods, even in small quantities? Please tick the box for the answer that you want to give.

Q.No	Food (Read each item)	Several times a day	Everyday	Several times a week	Once a week	Several times a month	Never
22	Fresh fruit						
23	Biscuits, cakes, wafers, buns, brad etc						
24	Lemonade, Mango shakes, Cola, other soft drinks, jam and honey						
25	Chewing gum containing sugars						
26	Sweets, candy, burfy, gajak etc						
27	Milk with sugar (Boost, complan, Milo etc)						
28	Tea/coffee with sugar						

How often do you use any of the following types of tobacco? **Please tick the box for the answer that you want to give**

Q.No	(Read each item)	Everyday	Several times a week	Once a week	Several times a month	Seldom	Never
29	I smoke cigarettes, pipes or cigars						
30	I use chewing tobacco or snuff						

31. How would you describe the health of your teeth and gums?
    a) Excellent
    b) Very good
    c) Good
    d) Average
    e) Poor
    f) Very poor
    g) Don't Know

32. Do you have tooth decay?
    a) Yes
    b) No
    c) Don't Know

33. How do you know if you have tooth decay? (You can tick more than one option)
    a) My parent told me
    b) My friend told me
    c) My dentist told me
    d) My doctor told me
    e) I found it myself
    f) I don't have tooth decay

34. If you have any doubts about your tooth or gums, what will you do? **(You can tick more than one option)**
    a) Ask my father (step-father or male guardian)
    b) Ask my mother (Step-mother or female guardian)
    c) Ask my friends
    d) Ask my siblings (brother or sister)
    e) Ask my teacher
    f) Dentist/doctor
    g) Others, if any, please write them here ____________________

35. If something got stuck between your teeth, what will you do?
    a) Use brush to remove
    b) Use tooth pick to remove
    c) I don't do anything
    d) Use floss to remove
    e) Use bobby pin or smoothing sharp to remove
    f) Food never stuck between my teeth
    g) Others, if any, please write them here _____________________

Please give your opinion about the following statement.

Q.No.	Statement	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
36	A person should make time to see the dentist at least once a year.					
37	It is my job to clean my teeth every day to have a nice smile.					
38	Brushing our teeth two times a day is not important.					
39	It is normal to get decay or tooth ache.					
40	I would like to know more about my teeth and brushing.					
41	No one ever talk to me about teeth and brushing.					

42. Do you have any other problem or something else you want to tell us on account of your mouth, teeth or gums?

____

____

____

Instructions: This is a story about a boy named Kumar. The story will help you to answer some questions. If you need help, please ask.

Kumar went to the dental clinic for a tooth extraction (remove) due to decay in his tooth. Dentist removed his tooth and instructed Kumar to bite the cotton for one hour and not to eat solid food for one hour. Dentist asked him not to spit or drink anything using straw for 24 hours. Dentist gave him 15 tablets and asked him to take medicine three times a day after food.

Please use the information in the passage to choose whether the statement is true or false.

Q.No.	Circle True or False for each statement:	True	False
43	Kumar has to bite the cotton for one hour.		
44	It is okay to eat a biscuit 30 minutes after the extraction		
45	Kumar has to take medicine for three days		
46	Kumar has to spit the cotton after one hour.		
47	Kumar's tooth was removed due to the decay.		

Thank you for completing this survey. Your help is much appreciated. Once you are finished please return your questionnaire to the researcher who will collect them from you.

Appendix G: Oral Health Literacy Quetionnaire (Tamil Version)

வாய்நல அறிவு வினாவிடை புத்தகம் – 2012

குறியீட்டு எண் ☐☐☐☐ ஆண் ☐ பெண் ☐

பின்வரும் வினாக்கள் ஒவ்வொன்றிக்கும் பதிலை அதற்கு அருகில் உள்ள எண்ணை வட்டமிடுதல் மூலம் தெரிவிக்கவும்.

1. உனது வயது என்ன?

12 ஆண்டுகள் / அதற்கு கீழ்	1
13 ஆண்டுகள்	2
14 ஆண்டுகள்	3
15 ஆண்டுகள்	4
16 ஆண்டுகள் / அதற்கு மேல்	5

2. உனது தந்தையின் (ஆண் பாதுகாவலர்/ ஒன்று விட்ட தந்தை) படிப்பறிவு என்ன?

8– ஆம் வகுப்பு/ அதற்கு குறைவாக	1
10– ம் வகுப்பு	2
12–ம் வகுப்பு	3
கல்லூரிக் கல்வி முடித்தவர்	4
மேற்குறிப்பிட்டவர் எவரும் எனது வீட்டில் இல்லை	5
தெரியாது	6

3. உனது தாயின் (அல்லது ஒன்று விட்ட தாய்/ பெண் பாதுகாவலர்) படிப்பறிவு என்ன?

8–ம் வகுப்பு / அதற்கு குறைவாக	1
10–ம் வகுப்பு	2
12–ம் வகுப்பு	3
கல்லூரிக் கல்வி முடித்தவர்	4
மேற்குறிப்பிட்டவர் எவரும் எனது வீட்டில் இல்லை	5
தெரியாது	6

4. உனது தந்தை என்ன பணி செய்கிறார்? ____________________

5. உனது தாய் என்ன பணி செய்கிறார்? ______________________

6. எந்த இனத்தை சார்ந்தவர்?

முற்பட்ட வகுப்பு (FC/OC)	1
பிற்படுத்தப்பட்ட வகுப்பு (BC)	2
மிக பிற்படுத்தப்பட்ட வகுப்பு (MBC)	3
அட்டவணை பிரிவு / பழங்குடியினர் (SC/ST)	4
தெரியாது	5

7. பல்லில் தோன்றும் கேவிட்டி (Cavity) என்றால் என்ன?

வெள்ளி அடைப்பு	1
பல்லில் சிறிய துளை	2
பல்லில் படிந்த பொருள்	3
தெரியாது	4

8. பிளாக் (Plaque) என்றால் என்ன?

பற்களுக்களுக்கு இடையில் சிக்கி உள்ள உணவுத் துண்டு	1
பற்குழி	2
பற்களில் மேல் படிந்த பொருள்	3
தெரியாது	4

9. பல் எனாமல் (Enamel) என்றால் என்ன?

பல்லின் கடினமான மேற்பாகம்	1
பற்குழி	2
பல்லின் உட்பகுதி	3
தெரியாது	4

10. இரு உணவுகளுக்கு இடைப்பட்ட காலத்தில் இனிப்புகள் உண்பதன் விளைவு என்ன?

பற்களுக்கு பாதிப்பு இல்லை	1
பற்கள் வளரும்	2
பற்களில் துளை ஏற்படும்	3
தெரியாது	4

11. பல் மருத்துவரை குழந்தைகள் எத்தனை முறை பார்க்க வேண்டும்?

6– மாதங்களுக்கு ஒருமுறை	1
2– ஆண்டுகளுக்கு ஒருமுறை	2
பல்லில் வலி வரும் போது மட்டும்	3
தெரியாது	4

12. பற்பசையில் உள்ள முக்கிய பொருட்களில் ஒன்று யாது?

புளூரைடு	1
குளோரைடு	2
சர்க்கரை	3
தெரியாது	4

13. பற்களுக்கு இடைப்பட்ட பகுதியை சுத்தம் செய்வது எவ்வாறு?

பல்தேய்க்கும் பிரஷ் கொண்டு	1
நூல் (பிளாஸ்) கொண்டு	2
இடைவெளிகளை சுத்தம் செய்ய தேவையில்லை	3
தெரியாது	4

14. எப்போதெல்லாம் பல் தேய்ப்பீர் ?

தேய்ப்பதில்லை	1
வாரம் ஒருமுறை	2
வாரம் 2– லிருந்து 6 முறைகள்	3
தினம் ஒரு முறை	4
தினம் 2 அல்லது அதற்கு மேற்பட்ட முறைகள்	5

பின்வருவனவற்றில் எவற்றைக் கொண்டு பற்கள், ஈறுகளை சுத்தம் செய்கிறாய்?
(சிறிதளவாக இருப்பினும் பதிலை உரிய இடத்தில் டிக் செய்யவும்.

	வகை	**தினம் ஒரு முறை**	**வாரம் பல முறை**	**வாரம் ஒரு முறை**	**எப்போதாவது**	**ஒரு போதும் இல்லை**
15	**பற்பசை**					
16	**பல் தேய்க்கும் பிரஷ்**					
17	**மரத்தாலான பல்குத்தி**					
18	**நூல் (பல் பிளாஷ்)**					
19	**கரி**					
20	**பல் தேய்க்கும் குச்சி**					
21	**நாக்கு வழிப்பான்**					

வேறு ஏதேனும் கொண்டு பற்கள், ஈறுகளை சுத்தம் செய்திருந்தால், கீழே குறிப்பிடவும்.________________________

பின்வரும் உணவு வகைகளை எத்தனை முறை உண்ணுவீர்? (சிறிதளவாக இருப்பினும் பதிலை உரிய இடத்தில் டிக் செய்யவும்.

	உணவுவகை	**தினம் பல முறை**	**தினம் ஒரு முறை**	**வாரம் பல முறை**	**வாரம் ஒரு முறை**	**மாதம் பல முறை**	**சாப்பிடுவதில்லை**
22	பழம்						
23	பிஸ்கட், கேக் வேபர், பன், பிரட்						
24	எலுமிச்சை, மாம்பழச்சாறு, கோலா போன்ற குளிர் பானங்கள், ஜாம்& தேன்						
25	சூவிங்கம்						
26	இனிப்புகள் மிட்டாய், பர்பி போன்றவை						
27	சர்க்கரை சேர்த்த பால்						
28	சர்க்கரை சேர்த்த தேநீர்						

எப்பொழுதெல்லாம் புகையிலைப் பொருட்கள் பயன்படுத்துகிறாய்? டிக் செய்யவும்

	வகை	தினமும்	வாரம் பலமுறை	வாரம் ஒருமுறை	எப்போதாவது	ஒரு போதும் இல்லை
29	சிகிரெட் / பீடி					
30	புகையிலை மெல்லுதல் / பொடி போடுதல்					

31. உனது பல் மற்றும் ஈறுகள் எந்நிலையில் உள்ளன?

மிகமிக நன்று 1
மிக நன்று 2
நன்று 3
சுமார் 4
மோசம் 5
மிக மோசம் 6
சொல்லத் தெரியவில்லை 7

32. உனது பற்கள் சொத்தையாக இருக்கின்றனவா?

ஆம் 1
இல்லை 2
தெரியாது 3

33. உனது பற்கள் சொத்தையாகி விட்டன என்று எவ்வாறு அறிவாய்? (ஒன்றிற்கும் மேற்பட்ட பதில்கள் அளிக்கலாம்)

பெற்றோர் மூலம் 1
நண்பன் மூலம் 2
பல்மருத்துவர் கூறினார் 3
பொது மருத்துவர் கூறினார் 4
நானே தெரிந்து கொண்டேன் 5
பற்கள் கெடவில்லை 6

34. பற்கள் ஈறுகள் பற்றி சந்தேகம் இருப்பின் என்ன செய்வாய்?
(தேவைப்பட்டால் ஒன்றிற்கும் மேற்பட்ட பதில்கள் தரலாம்)

தந்தையை விசாரிப்பேன் 1
தாயை விசாரிப்பேன் 2
நண்பனை கேட்பேன் 3
சகோதர/ சகோதிரிகளை விசாரிப்பேன் 4
ஆசிரியரிடம் விசாரிப்பேன் 5
வேறு வழி இருப்பின் கீழே குறிப்பிடவும்____________________

35. பற்களுக்கு இடையே ஏதேனும் சிக்கினால் என்ன செய்வாய்?

பிரஷால் எடுப்பேன்	1
பல்குத்தியால் எடுப்பேன்	2
ஏதும் செய்யமாட்டேன்	3
நூல் (பிளாஷ்) பயன்படுத்துவேன்	4
ஊசி போன்ற கூரான கருவியால் எடுப்பேன்	5
உணவுத் துண்டுகள் சிக்கியது கிடையாது	6

வேறு ஏதேனும் வழி இருப்பின் எழுதவும்.__________________________

பின்வரும் கூற்று ஒவ்வொன்றிற்கும் பதிலளிக்கவும்.

	கூற்று	மிகவும் சரி	சரி	நடுநிலை	தவறு	மிகவும் தவறு
36	ஆண்டிற்கு ஒருமுறை பல்மருத்துவரை பார்ப்பது அவசியம்					
37	ஒவ்வொரு நாளும் பற்களை சுத்தம் செய்வேன்					
38	தினம் இருமுறை பல்தேய்ப்பது முக்கியமில்லை					
39	பல்வலி, பல் சொத்தை இயல்பானதே					
40	பற்கள், அவற்றின் சொத்தை பற்றி மேலும் அறிய விரும்புகிறேன்					
41	பற்கள், பல் தேய்ப்பதைப் பற்றி யாரும் என்னிடம் பேசியதில்லை					

42. உனக்கு ஏதேனும் பல் பிரச்சனை உள்ளதா? வாய், பற்கள், ஈறு ஆகியனபற்றி ஏதேனும் கூற விருப்புகிறாயா? அவற்றை கீழே எழுதவும்.

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குறிப்பு: குமார் என்ற சிறுவனைப் பற்றிய கதை கீழே தரப்பட்டுள்ளது கதையைப் படித்து சில வினாக்களுக்கு பதில் அளிக்கவும். (உதவி வேண்டும் எனில் கேட்டுப் பெறவும்)

பற்கள் சொத்தையானதால் குமார் பல்மருத்துவரை அணுகினார். கெட்ட பல்லை பிடுங்கிவிட வேண்டினார். மருத்துவர் சொத்தையான பல்லை எடுத்துவிட்டார். அந்த இடத்தில் பஞ்சை வைத்து ஒரு மணி நேரம் கடித்துக் கொண்டிருக்ககுமாறு கூறினார். ஒரு மணி நேரத்திற்கு திட உணவு உட்கொள்ள வேண்டாம் என்றார். மேலும் 24 மணி நேரத்திற்கு துப்ப வேண்டாம்; ஸ்டிரா கொண்டு எதுவும் குடிக்க வேண்டாம் என்று அறிவுறுத்தினார். அவர் 15 மாத்திரைகளை கொடுத்தார். தினம் மூன்று முறை உணவுக்குப்பின் ஒரு மாத்திரை எடுக்குமாறு கூறினார். **இக்கதையைப் படித்து பின்வரும் கூற்றுகள் சரியா தவறா என டிக் செய்யவும்:**

		சரி	தவறு
43	குமார் ஒரு மணி நேரம் பஞ்சை கடித்துக் கொண்டிருப்பது		
44	முப்பது நிமிடங்களுக்கு பிறகு பிஸ்கட் உண்பது சரிதான்.		
45	மூன்று நாட்களுக்கு மட்டும் குமார் மருந்து உட்கொள்ள வேண்டும்.		
46	. ஒரு மணி நேரத்திற்கு பிறகு பஞ்சை துப்ப வேண்டும்		
47	சொத்தை யானதால் குமாரின் பல் பிடுக்கப்பட்டது.		

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விபரங்கள் அளித்தமைக்கு நன்றி. உதவிக்கு மிகுந்த பாராட்டுகள். பதிலளித்தவுடன் வினா–விடை புத்தகத்தைஆய்வாளரிடம் ஒப்படைக்கவும்.

Appendix H: Oral Health Examination Survey Form (Shah et al., 2007)

WHO ORAL HEALTH ASSESSMENT FORM (2004)

(Designed by WHO Oral Health Programme, Geneva)

Country	Year	Month Day	Identification number	Original duplicate	Examiner
(1) [redacted] (4)	(5) ☐☐ (6)	(7) ☐☐☐☐ (10)	(11) ☐☐☐☐ (14)	☐ (15)	☐ (16)

GENERAL INFORMATION Name:______________________ OTHER DATA (Specify and provide codes)

Age in years (17) ☐☐ (18)
(Box 17 & 18, Completed age in years

Geographic location (22) ☐☐ (23)
(Box 22, code of participating centre,
Box 23, code of selected group
1234 for Urban/5678 for Rural)

______________ ☐ (25)

Sex (M = 1, F = 2) ☐ (19)

______________ ☐ (26)

Ethnic group [redacted] (20)

Location type:
1=Urban
3 = Rural ☐ (24)

(Box 20, Not to be recorded)

Occupation ☐ (21)

______________ ☐ (27)

0 = Non skilled worker (Peon, Labourer, Farmer), 1 = Skilled worker (Carpenter, Masion), 2 = Professional, 3 = Businessman, 4 = Housewife, 5 = School going child, 6 = Non school going child, 7 = , 8 = Non-employed, 9 = No available information

EXTRA-ORAL EXAMINATION

0 = Normal ekstra-oral appearance
1 = Ulceration, sores, erosions, fissures (head, neck, limbs)
2 = Ulceration, sores, erosions, fissures (nose, cheeks, chin)
3 = Ulceration, sores, erosions, fissures (commissures) ☐ (28)
4 = Ulceration, sores, erosions, fissures (vermillion border)
5 = Cancrum oris
6 = Abnormalities of upper and lower lips
7 = Enlarged lymph nodes (head, neck)
8 = Other swellings of face and jaws
9 = Not recorded

DENTURE WEARING

Upper Lower
(29) ☐ ☐ (30)

0 = No denture
1 = Partial denture
2 = Full denture

DENTITION STATUS

55 54 53 52 51 61 62 63 64 65
18 17 16 15 14 13 12 11 21 22 23 24 25 26 27 28
Status
(31) (46)

85 84 83 82 81 71 72 73 74 75
48 47 46 45 44 43 42 41 31 32 33 34 35 36 37 38
Status
(47) (62)

STATUS

Permanent teeth	Primary teeth
0 = Sound	A
1 = Decayed	B
2 = Filled and decayed	C
3 = Filled, no decay	D
4 = Missing due caries	E
5 = Missing, any other reason	-
6 = Sealant, varnish	F
7 = Bridge abutment or special crown	G
8 = Unerupted tooth	-
9 = Excluded tooth	-
T = Trauma (Fracture)	T

PERIODONTAL STATUS (CPI modified)

55 54 53 52 51 61 62 63 64 65
18 17 16 15 14 13 12 11 21 21 22 23 24 25 26 27 28
Bleeding (63) (78)
Pocket (79) (94)

85 84 83 82 81 71 72 73 74 75
48 47 46 45 44 43 42 41 31 32 33 34 35 36 37 38
Bleeding (95) (110)
Pocket (111) (126)

Gingival bleeding scores:
(0) Absence of condition
(1) Presence of condition
(9) Tooth excluded
(X) Tooth not present

Pocket scores:
(0) Absence of condition
(1) Pocket 4–5 mm
(2) Pocket 6 mm or more
(9) Tooth excluded
(X) Tooth not present

LOSS OF ATTACHMENT

0 = 0–3 mm
1 = 4–5 mm (cementoenamel junction (CEJ) within black band)
2 = 6–8 mm (CEJ between upper limit of black band and 8.5 mm ring)
3 = 9–11 mm (CEJ between 8.5 mm and 11.5 mm ring)
4 = 12 mm or more (CEJ beyond 11.5 mm ring)
X= Excluded sextant
9 = Not recorded
* Not recorded under 15 years of age

17/16 11 26/27
(127) (129)
(130) (132)
47/46 31 36/37

ORAL MUCOSA

CONDITION

(133) ☐ ☐ (134)
(135) ☐ ☐ (136)
(137) ☐ ☐ (138)

0 = No abnormal condition
1 = Malignant tumour (oral cancer)
2 = Leukoplakia
3 = Lichen planus
4 = Ulceration (apthous, herpetic, traumatic)
5 = Acute necrotizing gingivitis
6 = Candidiasis
7 = Abscess
8 = Other condition (specify if possible) ....
9 = Not recorded

LOCATION

0 = Vermillion border
1 = Commissures
2 = Lips
3 = Sulci
4 = Buccal mucosa
5 = Floor of mouth
6 = Tongue
7 = Hard and/or soft palate
8 = Alveolar ridges/gingiva
9 = Not recorded

FLUOROSIS

☐ (139)

0 = Normal
1 = Questionable
2 = Very mild
3 = Mild
4 = Moderate
5 = Severe
8 = Excluded
9 = Not recorded

NEED FOR IMMEDIATE CARE

Life threatening condition ☐ (140)
Jaws fracture ☐ (141)
Pain or infection ☐ (142)
Referral to care ☐ (143)

0 = Absent
1 = Present/referral

Appendix I: Parents /Caregivers Information Leaflet

email:arthi.veerasamy@pg.canterbury.ac.nz

If you have any queries or concerns regarding your rights as a participant in this study, you may wish to contact an independent Health and Disability Advocate, as follows:
South Island 0800 377 766 Free Fax (NZ wide) 0800 2787 7678 (0800 2 SUPPORT).
E-mail: advocacy@hdc.org.nz

Supervisors of the study:

Assoc Prof Ray Kirk, Director of the Heath Science Centre, Phone: + 64 3 364-3108.
E-mail: ray.kirk@canterbury.ac.nz
Dr Jeffrey Gage, Phone: + 64 3 366 7001 ext 7403,
E-mail: Jeffrey.Gage@canterbury.ac.nz
Health Science Centre,
University of Canterbury,
Private Bag 4800,
Christchurch,
New Zealand.

Thank you for considering taking part in this study and for taking time to read this Information sheet.

9th January, 2012

9th January, 2012

UNIVERSITY OF CANTERBURY
Te Whare Wānanga o Waitaha
CHRISTCHURCH NEW ZEALAND

PARENT INFORMATION LEAFLET

Epidemiology of dental caries, treatment needs and oral health literacy of children (13-15 year-old); and teachers' perspectives on oral health education in urban and rural schools of Tamil Nadu, India.

- The University of Canterbury is conducting a study to find out about level of oral health status and oral health literacy among 13-15 years old school children.
- The study is conducted for a PhD project by a PhD candidate from the Health Sciences Centre, University of Canterbury.
- This study will include your child completing a survey questionnaire and oral health examination.
- We would like you to help us to find out about the level of oral health literacy and current oral health status of 13-15 year-old children by allowing your child to take part taking part in this study.
- You do not have to allow your child to take part if you prefer not to.

9th January, 2012

Please take your time to read this information sheet carefully.

If you decide allow your child to participate, we will be very grateful for your contribution to better understanding of oral health literacy and its importance. If you decide not to allow your child to participate, there will be no disadvantage to you or your child and we thank you for considering our request.

1. **What is the aim of this study?**
   The aim of this study is to find the current oral health status and the level of oral health literacy of children regarding their oral health.

2. **Who can participate?**
   Children in the age group between 13 and 15 can participate in the study.

3. **How many participants will be involved?**
   We hope that 1000-1100 children will complete our health examination and survey

4. **What is your participation?**
   Your child's participation is voluntary and your child/children are free to withdraw from the study at anytime without having to give a reason. There will be no disadvantage to your child. **Your child's name and personal details are strictly confidential and will not be mentioned in the final report.** If

you decide to allow your child to participate, you will be asked to sign a consent form when you confirm your willingness to be involved.

5. **Where will the survey completed?**
   The survey will be completed in your child's school.

6. **What questions will your children are asked?**
   Your child will be asked for unidentifiable (**no name**) information about their knowledge and attitudes regarding their oral health. This should take about 15-20 minutes maximum to answer.

7. **What will happen to the information?**
   Every participant will be identified with a study number (no name will be used). All the information will be kept in a secure location at the Health Sciences Centre/University of Canterbury. Only the researcher and two supervisors will have access to it to enable your answers to be analysed.

8. **What are the risks and the benefits of the study?**
   There is a slight risk that children may feel uncomfortable about some of the topics. If there are some questions your child does not want to answer, he/she are free not to answer.
   The oral health examination involves gingival probing which may cause a spread of infection. To avoid this risk all

international infection control protocols will be followed during the examination and separate autoclaved instruments will be used for each person. The researcher (Arthi Veerasamy) is a registered dentist in Tamil Nadu, India.
The benefit of the study is that your information can help to provide better oral health services for your children.

9. **What will happen to the results of the study?**
   It is expected that the final writing of the research will be done by the end of 2014. The final PhD report will be available to the public via the University of Canterbury library data base. You will receive a copy of the summary of the final report if you wish.

10. **Who pays for the research?**
    The study is financed by the University of Canterbury, New Zealand.

11. **Who has reviewed the study?**
    This study has received ethical approval from the Human Ethics committee, University of Canterbury and Institutional ethics board, Raga dental University, Chennai, Tamil Nadu.

12. **Where can you receive more information?**
    You can request more detailed information from the Principal researcher – Dr. Arthi Veerasamy, Health Science Centre/University of Canterbury, New Zealand. Phone: 03-3 667 001 ext. 8691 at the University.

Appendix J: Parent/Caregiver Consent Form

Thank you. Your child's participation in this study would be appreciated. Please return this consent form to the researcher.

9th January, 2012

9th January, 2012

UNIVERSITY OF CANTERBURY
Te Whare Wānanga o Waitaha
CHRISTCHURCH NEW ZEALAND

Health Sciences Centre

Tel: +64 3 364 2987, Fax: + 64 3 364 2490

Email: healthsciences@canterbury.ac.nz

PARENT/ CAREGIVER CONSENT FORM

For the study

Epidemiology of dental caries, treatment needs and oral health literacy of children (13-15 year-old); and teachers' perspectives on oral health education in urban and rural schools of Tamil Nadu, India.

9th January, 2012

Please tick to confirm.

- ☐ I have read and understand the information sheet for the above research study dated 9th[th] January 2012.
- ☐ I have had the opportunity to ask questions about the research study, and to discuss it with family and friends and have had time to consider whether to take part.
- ☐ I understand the purpose of the research study, and how my child will be involved.
- ☐ I understand that taking part in the study is voluntary (my choice) and I understood that my child may withdraw from it, at any time and for any reason.
- ☐ I understand that my child's participation in this study is confidential and that my child's name and personal details will not be included in the report.
- ☐ I wish to receive a summary of the study's results.
  Contact details:
  ____
  ____
  ____

I ____
(please print full name) consent to take part in the above research study.

Signed [Parent/Caregiver]
____________________________Date____________

Person taking consent/Researcher
____________________________Date____________

This study is being conducted by Dr Arthi Veerasamy, PhD student through the University of Canterbury/ Christchurch.

You can contact Arthi Veerasamy at the University: 03-3667001, ext: 8691

E-Mail address:
arthi.veerasamy@pg.canterbury.ac.nz

Supervision:

This project is being undertaken under University of Canterbury Health Sciences Centre supervision.

Supervisors of the study:

Assoc Prof Ray Kirk, Director of the Heath Sciences Centre, Phone: + 64 3 364-3108.
E-mail: ray.kirk@canterbury.ac.nz
Dr Jeffrey Gage, Phone: + 64 3 366 7001 ext 7403,
E-mail: Jeffrey.gage@canterbury.ac.nz
Health Sciences Centre,
University of Canterbury,
Private Bag 4800,
Christchurch.

9th January, 2012
9th January, 2012

Appendix K: Information to Students

Instructions for children

- We are conducting a research funded by University of Canterbury, Christchurch, New Zealand.
- Your participation is voluntary (You can stop being part of this whenever you wish). Even if your parents gave consent for your participation, you are free to withdraw from the study at anytime without having to give a reason. There will be no disadvantage to you.
- Firstly, everyone who interested to participate has to sign a consent form. Later, I will check your teeth and gums and write down the details. It will take 15-20 minutes.
- The oral health forms will be coded and your names will not be recorded anywhere. The code number will be given to you after the oral health examination.
- After I finish the oral health examination, I will distribute a questionnaire to fill. Instructions to fill the questionnaire are clearly given in the first page. If you have any doubt, ask me. Please write your code number given during the oral health examination.
- There is no correct or wrong answer and your answers will not affect your academic results in any way.
- If you do not know answer for any of the questions, mark the option "don't know".
- If you do not wish to answer any of the questions, you can skip that question and answer the next question.

Thank you for helping me.

Appendix L: Student Consent Form

I have understood the oral information about the study. I have asked questions and have received answers.

I ___________________________________

(please print full name) consent to take part in the above research study.

Signed (children)

________________________Date___________

__

Person taking consent/Researcher

________________________Date___________

This study is being conducted by Dr Arthi Veerasamy, PhD student through the University of Canterbury/ Christchurch.

You can contact Arthi Veerasamy at the University: 03-3667001, ext: 8691

E-Mail address:

arthi.veerasamy@pg.canterbury.ac.nz

I have understood the oral information about the study. I have asked questions and have received answers.

I ___________________________________

(please print full name) consent to take part in the above research study.

Signed (children)

________________________Date___________

__

Person taking consent/Researcher

________________________Date___________

This study is being conducted by Dr Arthi Veerasamy, PhD student through the University of Canterbury/ Christchurch.

You can contact Arthi Veerasamy at the University: 03-3667001, ext: 8691

E-Mail address:

arthi.veerasamy@pg.canterbury.ac.nz

I have understood the oral information about the study. I have asked questions and have received answers.

I ___________________________________

(please print full name) consent to take part in the above research study.

Signed (children)

________________________Date___________

__

Person taking consent/Researcher

________________________Date___________

This study is being conducted by Dr Arthi Veerasamy, PhD student through the University of Canterbury/ Christchurch.

You can contact Arthi Veerasamy at the University: 03-3667001, ext: 8691

E-Mail address:

arthi.veerasamy@pg.canterbury.ac.nz

Appendix M: Human Ethics Approval Letter: University of Canterbury

UNIVERSITY OF CANTERBURY
Te Whare Wānanga o Waitaha
CHRISTCHURCH NEW ZEALAND

HUMAN ETHICS COMMITTEE

Secretary, Lynda Griffioen
Email: human-ethics@canterbury.ac.nz

Ref: HEC 2012/07

27 February 2012

Arthi Veerasamy
Health Sciences Centre
UNIVERSITY OF CANTERBURY

Dear Arthi

The Human Ethics Committee advises that your research proposal "Epidemiology of dental caries, treatment needs and oral health literacy of children (13-15 year-old); and teachers' perspectives on oral health education in urban and rural schools of Tamil Nadu, India." has been considered and approved.

Please note that this approval is subject to the incorporation of the amendments you have provided in your email of 20 February 2012.

Best wishes for your project.

Yours sincerely

Michael Grimshaw
Chair
University of Canterbury Human Ethics Committee

University of Canterbury Private Bag 4800, Christchurch 8140, New Zealand. www.canterbury.ac.nz

E S

Appendix N: Human Ethics Approval (Institutional Ethics Committee, Tamil Nadu)

UC
UNIVERSITY OF CANTERBURY
Te Whare Wānanga o Waitaha
CHRISTCHURCH NEW ZEALAND

23rd January, 2012

The chair of Committee,

Institutional Ethics Committee,

Chennai,

Tamil Nadu

Dear Sir/Madam,

Subject: Requesting ethics approval for the research project.

Topic: Epidemiology of dental caries, treatment needs and oral health literacy of children (13-15 year-old); and teachers' perspectives on oral health education in urban and rural schools of Tamil Nadu, India.

I am PhD student at the University of Canterbury. I am presently undertaking a study on oral health literacy of children under the supervision of Associate Professor Ray Kirk (Director of Health sciences centre) and Dr Jeffrey Gage.

It is expected that the proposed research will discover the oral health status and the level of oral health literacy in children. The primary aim of this research project is preventing dental caries and this will be satisfied by answering such questions as:

- ✓ How many children have dental caries?
- ✓ How many of them have the awareness to prevent dental caries? And
- ✓ How and when should oral health education be included in schools to prevent dental caries?

The research will make recommendations to the Dental Council of India, and the Ministry of Education in order to improve the oral health of Children in Tamil Nadu by improving the oral health literacy of children. The research findings will also be used to provide recommendations for further research regarding better intervention to improve oral health literacy.

I am therefore seeking the ethical approval from your Institute's Ethics Committee for my research project. The project has been designed carefully with regards to following principles: informed consent of participants, the confidentiality of data and individuals, avoidance of any deception and the minimization of the risk to all participants.

The research involves an oral health examination and a measurement of the level of oral health literacy in children and individual face-to-face interviews of head teachers.

Oral health examination: Using the WHO oral health survey form the current status and treatment needs of children will be recorded. It will take takes 15 minutes to complete the oral examination in each child. Each oral health form will be numbered and that number will be given to each child after the oral examination. The oral health examination will involve gingival probing which may cause the spread of infection. To avoid this risk all international infection control protocols will be followed during the examination and separate autoclaved instruments will be used for each person.

Oral health literacy questionnaire: The questionnaire will be distributed to the participating children in a class room and everyone will be asked to write their code number given during the oral health examination. Instructions on how to fill the questionnaire will be given before they begin. It takes approximately 15-20 minutes to complete the self administered questionnaire.

Participating head teachers will be interviewed individually and interviews will be audio taped.

All of the information gathered will be treated with the strictest confidence and securely stored. No person or school will be mentioned in the thesis or subsequent reports and/or articles by name or in such a way that they can be identified.

The project has been approved by the Human Ethics Committee, University of Canterbury.

If you have any queries or would like clarification, please contact me.

My contact details are as follows:

Arthi Veerasamy
PhD Candidate
College of Education
University of Canterbury
Private bag 4800
Christchurch
E-mail: arthi.veerasamy@pg.canterbury.ac.nz
Phone: 03-3667001, ext: 8691

If you have any other concern, or you would like to talk to an independent person about the project you can contact either of the following:

Assoc Prof Ray Kirk

Director, Associate Professor, Health Information Management Convenor, and Co-Director Health Services Assessment Collaboration (HSAC)
Room: 204, Level 2,Waimairi Building
Phone: +64 3 364 3108
Fax: + 64 3 364 3318
ray.kirk@canterbury.ac.nz

Dr Mike Grimshaw

Chair, Human ethics Committee
Room: 302, School of Social & Political Sciences
Telephone: 6390 or +64 3 364 2390
michael.grimshaw@canterbury.ac.nz

INSTITUTIONAL ETHICAL COMMITTEE
SREE BALAJI DENTAL COLLEGE & HOSPITAL
CHENNAI-600 100.

PROFESSOR AND HOD
DEPARTMENT OF PERIODONTI
SREE BALAJI DENTAL COLLEGE
AND HOSPITAL
NARAYANAPURAM, PALLIKARANAI
CHENNAI - 601 302